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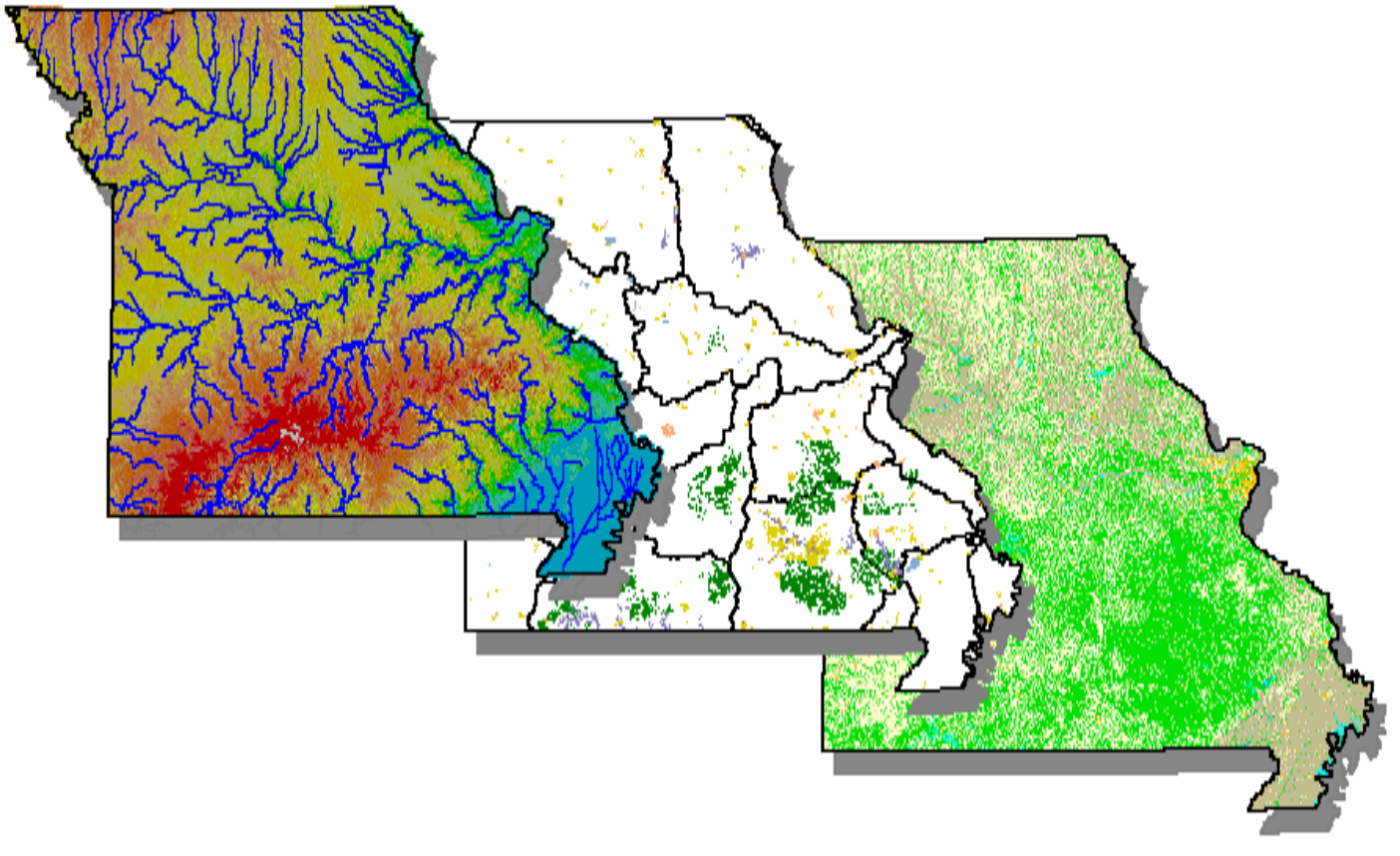
A GAP ANALYSIS FOR RIVERINE ECOSYSTEMS OF MISSOURI

GAP
National Gap Analysis Program

MoRAP

Appendices



A GEOGRAPHIC APPROACH TO PLANNING FOR BIOLOGICAL DIVERSITY

U.S. Department of the Interior
U.S. Geological Survey

APPENDIX 3.1
Biophysical descriptions for each Aquatic Subregion

Missouri is a physiographically diverse state situated in the east-central United States (Figure 1). This physiographic diversity can be generally described according the three Aquatic Subregions of the MoRAP aquatic ecological classification framework (See page 32 for an overview of the classification). The three subregions are remarkably different in their geologic, topographic, and edaphic features and these differences are reflected in the distributional relationships of their respective aquatic biota (Pflieger 1971).

Figure 1. Map of Missouri showing the major drainage systems and the three Aquatic Subregions that account for broad-scale differences in instream habitat and freshwater assemblages across the state.

Central Plains

Boundary

The boundary of the Central Plains Aquatic Subregion (CP) includes all of the drainages entering the Missouri and Mississippi Rivers north of the Missouri River, excluding those smaller drainages of the Missouri River downstream (east) of the outlet of the Chariton River, but including the Blackwater-Lamine drainage. It also includes portions of the Osage River watershed—the Osage River subbasin above the confluence with the Sac River and the entire South Grand River watershed (see Figure 1).

Climate

The CP has a mean annual temperature of 53 ° F that ranges from 52 in the northwest to 54 in the southwestern and southeastern corners of the Subregion. Mean July maximum temperatures vary only slightly (88 to 90° F) and follow a northeast to southwest gradient. Mean January minimum temperatures range from 12 ° F in the northwest to 18 ° F in the southeastern part of the Subregion.

Mean annual precipitation ranges from 34 inches in the extreme northwest section of the Subregion to 41 inches in the southwest. Precipitation is lowest in the winter with monthly averages typically less than 2 inches during this period, which is notably less than the other two Subregions. Mean annual snowfall is highest in this Subregion with an overall average of 20 inches. Precipitation is generally highest from late spring to early fall with monthly averages of around 4 to 5 inches. Like the rest of the state, however, most parts of this Subregion experience a noticeable dip in precipitation during hottest part of the summer—late July and August, which can prove to be a very stressful period for riverine biota (Smale and Rabeni 1995b).

Intense rainfall, drought, and both heat and cold waves occur throughout Missouri and can all serve as potential disturbances affecting community composition over short and long temporal scales and also local and broad spatial scales. Once every two years 24-hour rainfall totals of 3 to 4 inches are expected to occur in any given part of the state and in north Missouri temperatures above 90° F are recorded on an average of 40-50 days each year (Nigh and Schroeder 2002).

Landform

Topography of this Subregion can be generally described as low or gently rolling plains (Pflieger 1989; Unklesbay and Vineyard 1992) (Figure 2). Streams occupy broad flat valleys that almost imperceptibly grade into the surrounding uplands (Pflieger 1989). Surface elevations range from approximately 600 feet in the floodplains of the larger streams draining to the Mississippi River to 1,200 feet in the northwest corner of the state. Elevations along the divides separating the larger rivers range from ~ 800 to 1,000 feet. The CP is gently sloping and moderately dissected, even within those areas affected by glaciation, with an overall average land slope of 5% and local relief of 80 feet, but relief typically ranges from 50 to 200 feet.

Figure 2. Hillshade map of Missouri, generated from a 30-meter Digital Elevation Model, illustrating the major differences in landform among the three Aquatic Subregions in the state.

Geology and Soils

Geology more than any other physiographic feature provides the distinction between the CP and Ozark Subregions (Figure 3). The distributional limit of many species characteristic of the Ozarks correspond with the Mississippian-age geologic formations that generally separate the younger Pennsylvanian formations that dominate the CP and the older Ordovician formations that dominate the central Ozarks (Pflieger 1971). Bedrock within the CP consists mainly of Pennsylvanian-age (3.2 million ybp) shales, coal, sandstones, and limestones with shales accounting for the greatest surface area (Unklesbay and Vineyard 1992; Nigh and Schroeder 2002). Along the Mississippi River, particularly in the North River and Salt River watersheds, there is a region known as the Lincoln Anticline or Fold, which brings older Mississippian and Ordovician-age formations to the surface (Nigh and Schroeder 2002). The distribution of many species characteristic of the Ozarks (e.g., southern redbelly dace and smallmouth bass) also extend into this narrow belt (Pflieger 1997).

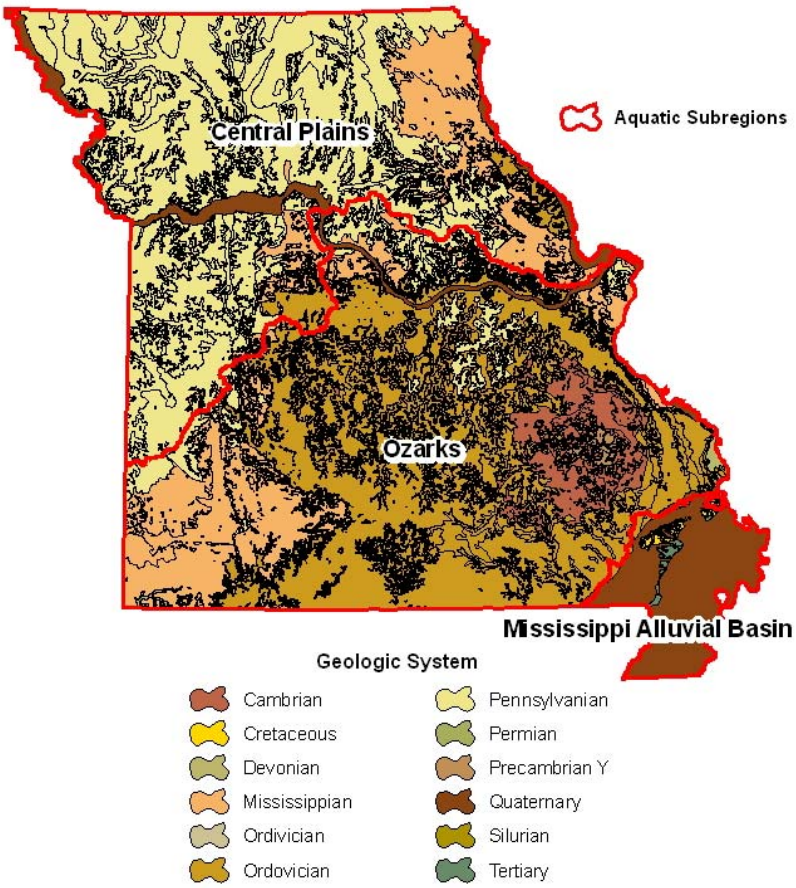


Figure 3. Map showing system-level geologic differences among the three Aquatic Subregions of Missouri.

As Nigh and Schroeder (2002) point out, the geography of soils in Missouri is quite complex as several contrasting soils can occur within a single hillslope sequence, yet broad regional patterns do exist. The CP is dominated by mollisols in the west/southwest and alfisols in the east/northeast. Although alfisols are generally thought to develop under forested conditions it is believed that both the mollisols and alfisols of this Subregion developed under prairie (Nigh and Schroeder 2002).

The original landscape of the Glaciated Plains subdivision was leveled by continental glaciation during the Pleistocene Epoch (2,000,000 ybp) and subsequently buried under layers of till and loess of varying thickness. Today this area north of the Missouri River consists of tills (sand, silt, and clays) that were largely derived from the disintegration of sandstones, limestones, and shales originating in Minnesota, Wisconsin, Iowa, Illinois, and northern Missouri (Hawker 1992). Loams and silty-loams with high to moderate infiltration rates are the dominant surface materials in much of this area. Highest infiltration rates occur along the loess bluffs bordering the Missouri and Mississippi Rivers. However, these relatively high infiltration rates are somewhat offset by the significantly steeper slopes of the loess bluffs, which promote runoff. The unglaciated Osage Plains is covered primarily by silty-clays and silty-clayey-loams with much slower

infiltration rates. The Audrain Plain in the eastern part of the Subregion also has very slow infiltration rates and high runoff due to the presence of an extensive claypan in the subsoil, which is why this area is also sometimes referred to as the “Claypan” region.

Historic vegetation

Prairies dominated the CP prior to extensive Euro-American settlement. Prairies occurred as both upland prairies and wet prairies on the wide alluvial plains along the major rivers (Nigh and Schroeder 2002). Headwaters were likely marshy and dominated by wetland grass complexes while the immediate riparian area of many, but not all, of the larger streams was forested (Menzel et al. 1984; Rabeni 1996). In addition, oak forests occurred in the hills and blufflands along the Missouri and Mississippi Rivers, except in northwestern Missouri where midgrass prairies occupied the deep-loess blufflands (Nigh and Schroeder 2002). Upland deciduous forests also dominated the more rugged Lincoln Hills (Thom and Wilson 1980).

Flow Regime, Physical Habitat, Water Chemistry, and Energy Dynamics

The shales and heavy clay subsoils that underlie most of this Subregion are poor aquifers. As a result, there are relatively few springs and those that do exist have very minimal discharge and most are highly mineralized (Figure 4) (Pflieger 1971; Vineyard and Feder 1974). Despite this lack of springs, it is generally believed that prior to European settlement the marshy headwaters, coupled with the deep prairie sod, absorbed rainfall like a sponge and released it slowly to the stream channels providing continuous perennial flow throughout much of the system—except during the driest years (Menzel et. al 1984; Rabeni 1996). Prairies are now largely gone, replaced by crop fields and intensively grazed fescue pastures that facilitate runoff, soil erosion, and sedimentation (Pflieger 1997). These and many other land use changes have substantially altered hydrologic regimes—particularly high and low flow conditions.

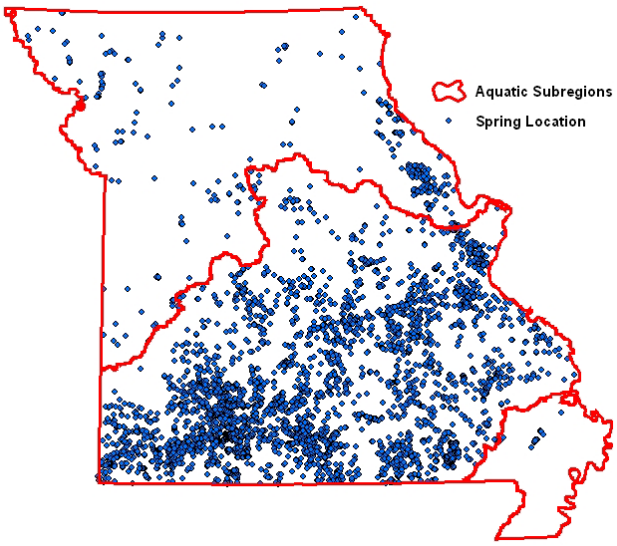


Figure 4. Map showing the distribution of springs in Missouri and the pronounce differences in the presence and density of springs among the three Aquatic Subregions.

Table 1 illustrates the present "flashy" nature and low-flow potential of streams within this Subregion. The ratio of the 10% to the 90% exceedence flows (10:90 ratio) is a commonly used measure of flow variability with higher numbers representing higher variability. The average 10:90 ratio for streams in the CP is 205 compared with only 15 for the Ozarks and 29 for the MAB (Table 1). Also, the 90% exceedence flow for the Lamine River at Otterville, MO is merely 7.7 cfs compared with 280 cfs for the similarly-sized North Fork River watershed at Tecumseh, MO, which is within the Ozark Subregion (Table 1). Collectively, the information provided in Table 1 reveals that streams in the CP; 1) are surface water dominated, 2) have widely fluctuating flow conditions, 3) have relatively high elevated and peak discharges, and 4) have extremely low base-flow discharges. The most surprising, and possibly the most ecologically relevant, fact from this table is that even the very large streams in this Subregion can become a mere trickle during extended dry periods.

Table 1. Hydrologic statistics for gaged streams representing each of the Aquatic Subregions in Missouri. The 90% and 10% values represent the 90% and 10% exceedence flows (cfs) for each gage site, while peak values represent the highest instantaneous peak discharge. The 10:90 ratio is a measure of the "flashiness" of the hydrologic response.

Central Plains	**Gage Location**	**Area (mi²)**	**90%**	**10%**	**Peak**	**10:90 Ratio**
Fox River	Wayland	400	1.8	500	26400	278
S. Fabius River	Taylor	620	4.1	850	19700	207
Salt River	New London	2480	28	3900	107000	139
Cuivre River	Troy	903	4.8	1200	120000	250
Platte River	Agency	1760	20	2100	60800	105
Grand River	Gallatin	2250	24	2200	89800	92
Thompson River	Trenton	1670	29	2300	95000	79
Lamine River	Otterville	543	7.7	670	63700	87
Blackwater River	Blue Lick	1120	3.3	2000	54000	606
					Average	**205**
Ozark						
Big Piney River	Big Piney	560	120	1000	32700	8
Gasconade River	Rich Fountain	3180	500	6400	101000	13
Meramec River	Eureka	3788	500	5800	145000	12
St. Francis River	Patterson	956	50	2300	155000	46
N. Fork River	Tecumseh	570	280	1350	133000	5
Black River	Annapolis	484	120	1200	98500	10
Current River	Doniphan	2038	1200	4800	122000	4
Eleven Point River	Bardley	793	270	1500	49800	6
Spring River	Waco	1164	60	1850	151000	31
Elk River	Tiff City	872	85	1700	137000	20
					Average	**15**
MAB						
Little River	Morehouse	450	150	990	8250	7
LAnguille River	Palestine, AR	786	1175	10660	22803	9
Cache River	Egypt, AR	701	38	2740	8940	72
St. Francis River	Lake City, AR	2374	280	7500	42700	27
					Average	**29**

Water is normally a calcium-magnesium-bicarbonate type and total dissolved solids are generally less than 500 mg/l (VanDike 1995). Historically, within these relatively open upland prairie stream systems, autotrophic processes dominated and the energy to drive the system was supplied principally by algal production and secondarily by riparian grasses (Rabeni 1996). Farther downstream, forested bottomlands were more prevalent, and riparian shrubs and trees provided the dominant organic energy source. Presently, many streams are no longer nutrient limited, as both point and nonpoint pollution sources have significantly increased nitrate, phosphate, ammonia concentrations, particularly during elevated discharges (Jones et al. 1984; Perkins et al. 1998). In fact, nutrient concentrations within the CP are among the highest in the Midwest (Jones et al. 1984).

Low dissolved oxygen concentrations are quite common throughout this Subregion, especially during summer and winter (Pflieger 1971; Smale and Rabeni 1995b). To what extent agricultural practices have influenced the spatiotemporal prevalence and severity of hypoxic conditions is not known (Smale and Rabeni 1995b). Considering that many of the characteristic fish species of this Subregion are tolerant of hypoxic conditions suggests that such conditions occurred naturally and played a strong selective role in the evolution of this Subregions riverine fauna (Matthews 1987; Smale and Rabeni 1995a, 1995b).

Average channel gradients, in meters per kilometer, are 10.3 for headwaters, 2.3 for creeks, 0.7 for small rivers, and 0.3 for large rivers (Figure 5). These values are almost exactly intermediate between those of the other two Subregions—for every stream size class. Gradient differences between the three Subregions are most pronounced among headwater streams and become less pronounced as stream size increases. Historically, headwater streams had well defined pools and riffles and further downstream pools would become quite long and riffles were short, poorly developed, or often completely absent. Larger streams use to be extremely sinuous, which maintained high habitat diversity (diversity of depths, velocities and substrates). Silt, sand and fine gravel are the predominant bottom types. Bedrock is exposed only in some upland tributaries that have cut completely through the thick mantle of glacial till, and in some larger streams that transgress divides of the preglacial drainage. Streams within most of this Subregion are believed to have at one time carried much clearer and cooler water than they do today (Pflieger 1971; Rabeni 1996). Row-crop agriculture, grazing, channelization, roads, and removal of riparian vegetation have collectively led to substantially elevated sediment loads and temperatures in these streams. Even slight elevations in discharge will render these streams turbid due to resuspension of the abundant fine sediments that dominate the stream bottoms and banks. Only during extended base-flow conditions will most streams achieve any sort of clarity.

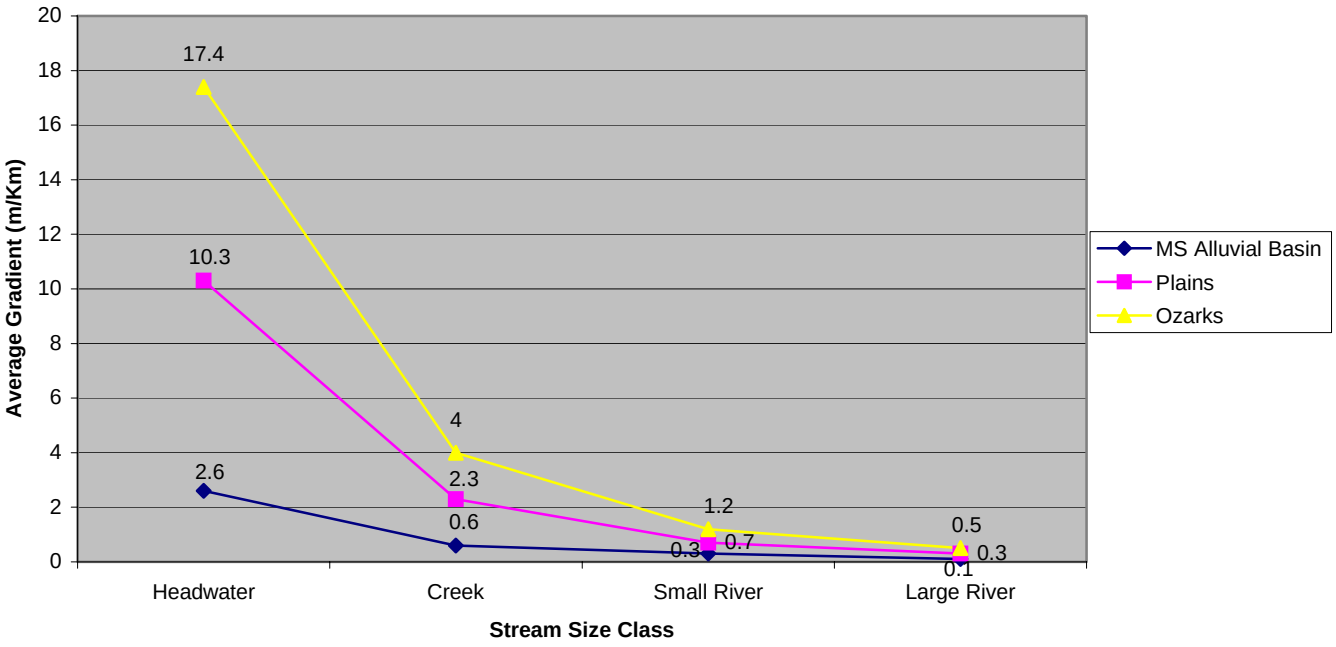


Figure 5. A comparison of the average stream gradients (m/km) for four stream size classes within each of the Aquatic Subregions in Missouri

Historically, the larger streams in this Subregion would freely meander across their broad-valleys and in the process create numerous backwater sloughs and oxbows. These lentic floodplain habitats served as important accumulators and tranformers of both autotrophic and heterotrophic energy sources, which the adjacent river and biota would access during overbank flows. They also served as important reproductive and nursery habitats for many fish species, as well as, the principle habitat for many crayfish, mussel, and amphibian species.

Presently there are very few channels, of any size, that have not been channelized or straightened to some degree. Almost all of the sloughs and oxbows have been drained and filled. These once diverse stream ecosystems have subsequently become remarkably homogenous in character; often straight as an arrow with uniform depths and velocities, and substrates dominated by sands and silts. Riffle habitats are not nearly as common as they historically were and woody structure has been, and continues to be, removed from most of the larger streams to further expedite the downstream transmission of water.

Large impoundments are not as prevalent as in the Ozark Subregion. Mark Twain, Thomashill, Long Branch, and Smithville reservoirs are the four major impoundments north of the Missouri River. South of the Missouri River the Harry S. Truman reservoir impounds the lower portions of the South Grand River and Tebo Creek. It has been estimated that approximately 300,000+ small artificial waterbodies (less than 2.5 acres)

have been constructed in Missouri (Vandike 1995; Smith et al. 2002). The vast majority of these occur in the CP (Pflieger 1971; Nigh and Schroeder 2002). The ecological effects of these artificial waterbodies include the expansion of predatory game species (e.g., largemouth bass and bluegill) into entire regions or watersheds and more locally into headwater streams where they historically did not occur (Pflieger 1997), increased evaporation rates, diversion and delay of the downstream transmission of water, and altered biochemical reactions and groundwater interactions (Smith et al. 2002).

Biota

The CP Aquatic Subregion supports the second most diverse aquatic fauna in Missouri with a total of 190 species (141 fish, 42 mussels, and 7 crayfish). However, this number is somewhat misleading due to the large size of the CP and the fact that many species more characteristic of the Ozarks occur along the periphery of the CP. The local assemblage found in most streams of the CP is in most instances much lower than the other two Subregions. This occurs because CP streams are harsh environments for aquatic fauna with widely fluctuating environmental conditions and only species that can tolerate such conditions can persist (Pfliger 1997). Because the species that occur in the CP can live in a variety of environmental conditions they generally have much broader geographic ranges than species found in the other two Subregions (Pflieger 1997). Only two species, one fish (Topeka shiner: *Notropis topeka*) and one crayfish (grassland crayfis: *Procambarus gracilis*), are endemic to the CP.

The 138 fish species represent 25 different families. According to NatureServe's natural heritage database, two species are classified as globally threatened or endangered while fourteen are listed as state threatened or endangered. All but one of the native mussel species falls within the family Unionidae and one of three subfamilies, Ambleminae, Lampsilinae, and Anodontinae. The most common and widespread species are the giant floater (*Pyganodon grandis*), pondmussel (*Ligumia subrostrata*), fatmucket (*Lampsilis siliquoidea*), and paper pondshell (*Utterbackia imbecillis*). No mussel species are endemic to the CP. Three species are listed as globally threatened and seven are listed as state threatened or endangered. Only six crayfish species inhabit the streams of the CP Aquatic Subregion. The most common and widespread species are the virile crayfish (*Orconectes virilis*), papershell (*Orconectes immunis*), and grassland (*Procambarus gracilis*) crayfish. No crayfish species are listed as either global or state threatened or endangered.

Ozarks

Boundary

The Ozark Subregion includes all of the smaller direct tributaries to the Missouri River downstream from the outlet of the Little Chariton River, excluding the Blackwater/Lamine drainage (see Figure 1). It includes the eastern third of the Osage River watershed, downstream from, and including, the Sac River watershed, but excluding the South Grand River watershed. It also includes the entire Gasconade and Meramec River watersheds and those portions of the Neosho and White River watersheds that fall within Missouri. The southeast boundary with the MAB is marked by an abrupt change in elevation, relief, and surficial materials. This boundary affects streams like the Eleven Point, Current, Black, and St. Francis River that drain some of the most rugged and characteristic Ozark landscapes, but eventually flow into the MAB with a corresponding abrupt change in physicochemical conditions. The mainstems of these large rivers were clipped at this abrupt change in physiographic conditions and all of the tributaries (and their watersheds) that flowed into these mainstems while they were cutting through the Ozarks were included as part of the Ozark Subregion. Lastly, it includes all of the small direct tributaries to the Mississippi River between the outlet of the Headwater Diversion Channel near Cape Girardeau, Missouri and the outlet of the St. Francis River near Helena, Arkansas.

Three physiographic subdivisions of the Ozarks are widely recognized in Missouri: the St. Francois Mountains, the Salem Plateau, and the Springfield Plateau (Pflieger 1971; Jacobson and Primm 1997). The St. Francois Mountains is a small area of igneous knobs and peaks located in southeast Missouri, which covers much of the St. Francis River watershed and minor portions of the Black and Meramec River watersheds. The Salem Plateau is the largest subdivision and is coextensive with those areas of the Ozarks underlain by Ordovician age and older sedimentary rocks. The Springfield Plateau lies west of the Salem Plateau and is coextensive with those areas underlain by Mississippian age rocks. Our discussion of variations in physiographic character and stream conditions will often be framed within these three subdivisions.

Climate

The Ozark Subregion has a mean annual temperature of 55 ° F and ranges from 54 in the north to 56 in the southeastern corners of the Subregion. Mean July maximum temperatures are a fairly uniform 90° F, however, slightly lower maximums occur in the central Ozarks. Mean January minimum temperatures range from 16 ° F in the northeast to 22° F in the southeastern part of the Subregion.

Mean annual precipitation ranges from 40 inches in the north to 48 inches in the southeast. Precipitation is lowest in the winter with monthly averages around 2 to 3 inches during this period. Estimated mean annual evapotranspiration is 30 to 35

inches/year. Precipitation is generally acidic with a low dissolved solids concentration (Adamski et al. 1995). There is a wide range of mean annual snowfall across the Subregion, but it is still a hydrologically insignificant form of precipitation (Tryon 1980). In the northeast snowfall averages 20 inches, but only half this amount generally falls in the southeast corner. Precipitation is generally highest from late spring to early fall with monthly averages of around 3 to 5 inches but, like the Central Plains Subregion, there is a noticeable dip in precipitation during hottest part of the summer; late July and August.

Landform

Topography of the Ozark Subregion is highly variable ranging from very steep in those areas bordering the major streams to nearly level along many of the drainage divides (Thom and Wilson 1980) (see Figure 2). Valleys in the upper parts of basins are generally wide with gradual slopes extending from the stream channel to the valley wall (Jacobson and Primm 1997). Larger streams occupy narrow, steep-sided, valleys that are frequently bordered by high bluffs (Pflieger 1989). Surface elevations range from approximately 400 feet in the floodplains of the larger streams draining to the Mississippi River to almost 1,800 feet at Tom Sauk Mountain—the highest elevation in Missouri. Elevations along the divides separating the major drainages typically range from 1200 to 1,600 feet in the central Ozarks.

The Subregion is moderately sloping and highly dissected with an overall average land slope of 9% and local relief of 148 feet, however local relief of 300 feet or more is common (Thom and Wilson 1980). Slopes greater than 20% are most common in the St. Francois Mountains and the Salem Plateau, particularly in those lands bordering the major rivers. The Springfield Plateau has much lower slopes and local relief, which are comparable to those found in northwestern Missouri.

Geology and Soils

Geologically, the Ozarks is one of the oldest regions of the world, having been an exposed, unglaciated, land surface since the end of the Paleozoic Era (Steyermark 1959). The Subregion is characterized by a core of Precambrian igneous rocks that underlie the St. Francois Mountains surrounded by nearly flat-lying Paleozoic sedimentary rocks of Cambrian, Ordovician, and Mississippian age (Jacobson and Primm 1997) (see Figure 3). Ordovician age rocks are the dominant underlying structure within the Salem Plateau. The Springfield Plateau is primarily underlain with Mississippian and Pennsylvanian age rocks, which also underlie the northern edge of the Ozarks along the Missouri River. As previously stated, the distributional limit of many species characteristic of the Ozarks correspond with the Mississippian-age geologic formations that separate the younger Pennsylvanian formations that dominate the Central Plains from the older Ordovician formations that dominate the central Ozarks (Pflieger 1971). The sedimentary rocks of this Subregion are dominated by

cherty limestone and dolomite, with smaller contributions of sandstone and shale (Jacobson and Primm 1997).

The alfisols and ultisols that dominate the Ozarks are generally considered “poor” and are unsuited for row-crop agriculture except within the alluvial flooplains along the larger rivers and some of the broad flat ridgetops. Weathering of the carbonate rocks has produced a variable thickness of residuum. On areas of low slope and chert-rich rocks, clay- and gravel-rich residuum and colluvium can accumulate to as much as 6 or 7 meters thick (Jacobson and Primm 1997). Steeper slopes have thin, clay-rich soils, or no soil at all. Most soils fall within the NRCS Hydrologic Soil Groups B or C (i.e., moderate to slow infiltration rates) (See Figure 7) and have high potential to leech nutrients to groundwater and a high potential for runoff during periods of intense rainfall that bypass the karst drainage system (Jacobson and Primm 1997; Adamski et al. 1995). In areas of high relief and steep slopes the surface texture of soils range from coarse-loam to very coarse-silty-loam. Gradual sloping areas are dominated by silty-loams. Extremely stony soils occur in the St. Francois Mountains and also in those lands just north of the Missouri River between the outlet of the Osage River and the city of St. Louis.

Historic vegetation

Presettlement vegetation included forests, woodland, savanna, and significant prairie tracts (Nigh and Schroeder 2002). Forests covered most of the Salem Plateau and St. Francois Mountains. Oaks dominated most of the forests, however, pine was codominant and sometimes occurred as nearly pure stands in the southern and southeastern sections of the Subregion (Nigh and Schroeder 2002). Bottomlands were typically covered in deciduous forest. These lowland forests generally contained a larger variety of species including sycamore, cottonwood, maple, black walnut, butternut, hackberry, popular, and bur oaks (Adamski et al. 1995). Prairies occurred in small to moderately sized tracts along the outer belts of the Ozarks and were most abundant within the Springfield Plateau. These prairies generally occurred on the smooth uplands while the bottomlands were forested (Sauer 1920). These scattered upland prairies along the northern and western border of the Ozarks represented a transitional vegetative cover between the forested interior of the Ozark Subregion and the more extensive prairie tracts of the Central Plains Subregion.

Flow Regime, Physical Habitat, Water Chemistry, and Energy Dynamics

Within the soluble carbonate rocks (i.e., limestone and dolomite) that dominate the Ozarks a karst drainage system has developed with abundant caves, sinkholes, springs, and underground streams (Vineyard and Feder 1974; Adamski et al. 1995). This karst topography creates significant interactions between surface and groundwater (Petersen et al. 1998). Losing streams, which are scattered throughout the Subregion, are one example of this interaction. Losing streams lose a portion or all of their flow to

the underlying groundwater system. Even fairly large streams like the aptly named Dry Fork, that have surface flow during base flow in their upper reaches, become completely dry for considerably long stretches only to regain surface flow further downstream.

As previously mentioned, the average 10:90 ratio for selected Ozark streams is only 15 (see Table 1). This low number indicates the general stability and high baseflow potential of Ozark streams. These high base flows are the result of relatively high groundwater inputs from conduit or diffuse springs, which are extremely abundant throughout the Ozarks, especially within the Salem Plateau (see Figure 4). Highest spring densities occur within the White River drainage, while the highest concentration of large springs occurs within the Gasconade and Current River drainages, particularly within the Ozark National Scenic Riverways. These large springs have enormous underground contributing areas and some have flows as large as small rivers (Vineyard and Feder 1974; Pflieger 1989). Streams that receive water from a large spring may maintain water temperatures suitable for supporting coldwater fisheries for a considerable distance below the spring (Pflieger 1975). Sections of several Ozark streams are classified as coldwater and all but a few contain naturalized populations of rainbow trout or put and take fisheries of brown and rainbow trout.

On a per unit area basis (unit discharge), peak discharges in Ozark streams are often considerably larger than the other two Subregions. The shallow soils coupled with the steep terrain can produce tremendous surface runoff during intense rainfall events that bypass the karst drainage system. Average unit discharge for peak flows recorded at selected gage stations on Ozark streams is 120 cfs per square mile, compared with 63 in the CP and only 20 in the MAB (see Table 1). Highest unit discharges occur in the St. Francis, Elk, Spring, and Black River watersheds, which have lower spring densities and fewer large springs than the other Ozark watersheds included in Table 1. Consequently, despite the relatively high baseflow discharge of Ozark streams, surface runoff from intense storms can produce amazingly high unit discharges and it is quite common to find woody debris left behind from flooding as high up as 15 to 20 feet within the surrounding riparian vegetation (S. Sowa, personal observation).

Many natural factors affect water quality in the Ozarks including climate, physiography, geology, and soils. These factors are particularly influential to stream water quality during periods of low flow when the percent of ground-water contribution is high (Adamski et al. 1995). The Springfield and Salem Plateaus have very similar water quality, but dissolved solids and alkalinity are lower in the Springfield Plateau. Waters in the Springfield Plateau are calcium bicarbonate, whereas Salem Plateau waters are calcium magnesium bicarbonate due to the greater prevalence of dolomite bedrock. The St. Francois Mountains waters are also calcium magnesium bicarbonate, but are less mineralized than many other waters in the Subregion due to the prevalence of resistant igneous rocks (Adamski et al. 1995). As a whole, Ozark streams are quite clear and even on most of the larger streams one can easily see the bottom of the deepest pools during baseflow.

Nutrient concentrations in streams with largely forested watersheds are some of the lowest in the Nation while concentrations in streams draining other land uses (e.g.,

urban and cropland) are some of the highest in the Nation (Jones et al. 1984; Petersen et al. 1998). Pesticide and other organic compound concentrations are generally low, while concentrations of semivolatile organic compounds in bed sediments downstream from urban areas are some of the highest in the Nation (Brookshire 1997; Petersen et al. 1998). Trace element concentrations in lead and zinc mining areas of the Ozarks are also higher than many other regions of the country.

Low dissolved oxygen concentrations are generally not a problem in Ozark streams (Brookshire 1997). However, low concentrations can and do occur within the intermittent pools of headwater streams from late summer through winter due to high temperatures and high biological oxygen demand resulting from the decay of organic matter trapped within these pools (Matthews 1998). Low dissolved oxygen concentrations also occur below some of the large impoundments within the Subregion. These coolwater Ozark streams and their associated aquatic assemblages are susceptible to elevated temperatures (Sowa 1993; Smale and Rabeni 1995b). Removal or thinning of riparian vegetation is a common practice in the Ozarks (Jacobson and Pugh 1997). This activity not only increases the amount of solar radiation reaching the stream surface, but also results in wider and shallower channels (Fajen 1981). This widening and reduction in depth increases the surface area per unit volume of water, which leads to further increases in solar radiation inputs per unit length of stream.

Headwaters generally have shallow valleys and steep gradients averaging 17.4 m/Km but ranging as high as 40 or 50 m/Km (see Figure 5). Stream reaches are characterized by short pools and well-defined riffles with substrates comprised of gravel, cobble, boulder and bedrock. Small springs and seeps are common especially within the south and southeastern Ozarks. Many headwater streams have intermittent flow, meaning they may be dry with the exception of the deepest pools during the summer (Pflieger 1989). Creeks have deeper valleys and significantly lower gradients that the headwaters—averaging 4 m/Km (see Figure 5). Riffle substrates are generally gravel and cobble while the substrate in pools will include detritus, sand, and silt in addition to coarser substrates. Gravel bars on convex banks are common as are extensive stretches of exposed bedrock, especially when the channel is near the valley wall (S. Sowa, unpublished data). As with headwater streams all except the largest and deepest pools may be dry during the summer.

Valleys of small rivers are characteristically narrow and steep sided (Jacobson and Primm 1997). These valleys are frequently entrenched from downcutting during past periods of uplift and may be up to 300-500 feet deep (Fenneman 1938). Limestone bluffs as high as 150 feet border these streams in many places and pools adjacent to these bluffs (i.e., bluff pools) are often extremely deep and contain large complexes of boulders. These bluff pools have been identified as important overwintering habitat for many species and are also a key habitat for the spectaclecase mussel (*Cumberlandia monodonta*) (Peterson 1996; Baird 2000). Gradients average 1.2 m/Km which is only slightly higher than the other two Subregions (see Figure 5). These small rivers exhibit deep pools with sand and silt bottoms, but riffles still contain mainly gravel and cobble substrates. Large springs are fairly common along these smaller mainstem streams,

which typically have permanent flow. Large rivers have wide deep valleys and with an average gradient of 0.5 m/Km (see Figure 5). Long pools and deep chutes along with backwaters and cut-offs typify these largest Ozark rivers. Pools have sand and silt bottoms, while swifter areas maintain gravel and cobble substrates, except for those streams directly entering the Missouri or Mississippi Rivers (e.g., Meramec and Gasconade Rivers). The substrates near the outlets of these rivers are almost entirely comprised of fine sediments due to backwater effects that occur during floods on the two great rivers. Backwater flooding is a phenomenon in which high water stages on the Missouri and Mississippi Rivers create a damming effect, preventing tributary drainage into the mainstem and at times even reversing tributary flow (Brown et al. 1999). This situation results in long-duration flooding accompanied by the deposition of fine sediments and nutrients throughout the lower ends of these tributaries, up to where the elevation on the tributary channel equals the elevation of the floodwaters on these great rivers.

Under natural conditions, the energy dynamics of Ozark streams nearly typify the synthesis put forth in the River Continuum Concept (Vannote et al. 1980). Headwaters and creeks are generally well shaded with little primary production and are heterotrophic—deriving most of their energy from allocthonous inputs from the surrounding riparian vegetation. The invertebrate community within these headwaters is dominated by shredders which breakdown the abundant coarse particulate organic matter. In small rivers the channels become wider and primary production increases such that photosynthesis is greater than respiration resulting in an autotrophic community. In these reaches there is a codominance of collector-filterers and scrapers, which feed on the attached algae. In large rivers (orders >6), the surrounding vegetation does not shade the stream, however, turbidity of the water inhibits primary production and even though the vegetation contributes little to the energy budget of the system, these reaches are also characterized as heterotrophic. However, some large rivers in the Ozarks (e.g., Current, Black, Meramec) maintain relatively clear waters and therefore maintain relatively high autotrophic production.

Biota

The Ozark Aquatic Subregion supports a highly diverse and distinctive aquatic fauna. A total of 296 species (202 fish, 65 mussels, and 29 crayfish) can be found in the flowing waters of this Subregion. Fifty-six of these species (25 fish, 9 mussels, and 18 crayfish), or 19%, have geographic ranges that are either entirely or nearly restricted to the Subregion. This high number of endemic species is a result of both the age of the Ozarks and the isolation of the principal drainage systems by the Great Rivers (e.g., Missouri and Mississippi Rivers) into which they drain (Pflieger 1971).

The 202 fish species represent 27 different families with the most dominant small fishes being minnows (Cyprinidae) and darters (Percidae) while suckers (Catastomidae) and sunfishes (Centrarchidae) are the dominant large species. Twenty six of these fish species are considered endemic to the Ozark Aquatic Subregion. According to

NatureServe's natural heritage database, 6 species are classified as globally threatened or endangered while 32 are listed as state threatened or endangered.

There are 63 native and two introduced mussel species in the Ozark Aquatic Subregion. All but one of the native species falls within the family Unionidae and one of three subfamilies, Ambleminae, Lampsilinae, and Anodontinae. The spectaclecase (*Cumberlandia monodonta*) is the only mussel species from the family Margaritiferidae in Missouri. The most common and widespread species are the giant floater (*Pyganodon grandis*), pondmussel (*Ligumia subrostrata*), fatmucket (*Lampsilis siliquoidea*), and paper pondshell (*Utterbackia imbecillis*). Nine mussel species have geographic ranges that are either entirely or nearly restricted to the Ozarks. Eleven species or subspecies are listed as globally threatened or endangered and twenty, or nearly 30%, are listed as state threatened or endangered.

Like all species of crayfish east of the Rocky Mountains, all of 29 crayfish species that inhabit Ozark streams fall within the family Cambaridae (Pflieger 1996). The most common and widespread species are the spothanded (*Orconectes punctimanus*), golden (*Orconectes luteus*), devil (*Cambarus diogenes*), and virile (*Orconectes virilis*) crayfish. Nearly three quarters (21 species, 72%) of the crayfish species found in Ozark streams are endemic to the Ozark Aquatic Subregion. Seven of these species are listed as globally threatened and 7 are listed as either state threatened or endangered.

Mississippi Alluvial Basin (MAB)

Boundary

The MAB includes the lower portions of the Current, Black, and St. Francis River watersheds. It also includes the Little River drainage, St. Johns Ditch and the New Madrid Floodway of the Mississippi River (see Figure 1). The Benton Hills and Crowley's Ridge, which are essentially topographic "islands" of Ozark character surrounded by a "sea" of nearly flat alluvial plain are also included within the MAB Subregion. The features defining the boundary between the MAB and the Ozarks is described above within the discussion of the boundary of the Ozark Subregion.

Climate

The MAB has the highest mean annual temperature and precipitation within the state. The mean annual temperature is 58 ° F and ranges from 57 in the north to nearly 59 in the south. Mean July maximum temperature is 90° F, which is essentially the same as the Ozarks, however, mean January minimum temperature is 24° F, which is slightly higher than the Ozarks and substantially higher than the Central Plains.

Mean annual precipitation is 50 inches. Unlike the other two Subregions, which generally receive the lowest amounts of precipitation during winter, precipitation in the MAB is lowest in late summer and early fall. There are generally two peaks in precipitation, one throughout the spring and again in late fall and early winter with monthly averages of around 5 inches during these two periods. Like the rest of the state, rainwater is generally acidic with a low dissolved solids concentration. On average this Subregion only receives 6 to 8 inches of snowfall each year.

Landform

The Mississippi River and its tributaries originally sculpted the MAB landscape producing a surface geomorphology consisting of natural levees, meander scar lakes, point bars, ridges, and swales (Brown et al. 1999). More generally this Subregion is characterized as a broad plain that averages 300 feet above sea level with a gentle slope to the south (see Figure 2). The overall average slope is less than 1% and overall average relief is approximately 10 feet. Crowley's Ridge, which rises anywhere from 50 to 250 feet above the surrounding plain, is the most prominent topographic feature of the Subregion. This topographic island has much higher slopes of approximately 5% and local relief ranging to 150 feet or slightly more in some places.

Geology and Soils

Bedrock is an unimportant feature of MAB landscape except within Crowley's Ridge, which is underlain mainly by Cretaceous and Tertiary sandstones, siltstones and shales with some minor inclusions of Ordovician sandstones and dolomites (see Figure 3).

Crowley's Ridge is capped by a relatively thick mantle of windblown loess deposits similar to those found along the bluffs of the Missouri and Mississippi Rivers in other parts of the state (Pflieger 1971). The remainder of the MAB is underlain by Cretaceous and Tertiary deposits of clay, sand, and gravel that range from a few feet to more than 2,700 feet in thickness (Grohskopf 1955). These older sediments are buried under a layer of alluvium deposited by the St. Francis, Mississippi, and Ohio rivers during Pleistocene and recent times (Pflieger 1971). Inceptisols and entisols with relatively low infiltration capacities dominate the alluvial bottoms of the larger rivers and ditches while higher ground is covered primarily by alfisols with moderate to high infiltration capacities (Nigh and Schroeder 2002).

Historic vegetation

In its original condition the MAB was one of the most heavily timbered regions of Missouri (Pflieger 1971). Also, despite the nearly level landscape of this Subregion, a relatively high water table combined with varied soils provided a diverse landscape for plant communities to form. Site conditions within the MAB ranged from permanently flooded areas supporting only emergent or floating aquatic vegetation, to high elevation sites supporting complex hardwood forests (Brown et al. 1999). The dominant historic natural communities included various types of bottomland hardwood forests, but major areas consisted of upland deciduous forests dominated by oaks and smaller areas associated with sandy ridges supported prairie and oak savanna (Nigh and Schroeder 2002). The distribution of community types and successional stages of the bottomland hardwood forests was partly determined by the timing, frequency, and duration of flooding (Brown et al. 1999). Elevational differences of only a few inches resulted in great differences in soil saturation characteristics and plant distribution. As a result, components of this bottomland hardwood ecosystem ranged from bald cypress/tupelo swamp communities in saturated or inundated situations, to a cherrybark oak/pecan community where inundation is infrequent and temporary (Brown et al. 1999). Between these distinct types are transitional overcup oak/water hickory, elm/ash/hackberry, and sweetgum/red oak communities.

Of all the regions of Missouri, the MAB has lost the greatest part of its historic vegetation with only a few small remnants of the nineteenth century forest cover remaining (Nigh and Schroeder 2002). Almost 95% (excluding Crowley's Ridge) of this Subregion has been drained and converted to farmland with the vast majority being cropland; particularly soybeans, wheat, corn, cotton, and rice. The only extensive areas of standing timber and swamps that remain are Duck Creek Conservation Area and Mingo National Wildlife Refuge. Other smaller remnants include Otter Slough, Alldred Lake, Wolf Bayou, Big Oak Tree State Park, and Cash Swamp.

Flow Regime, Physical Habitat, Water Chemistry, and Energy Dynamics

The MAB is now a region of few natural alluvial rivers as a result of one of the world's most ambitious land clearing and drainage efforts that took place during the first half of the twentieth century. This once swamp- and wetland-dominated landscape is now covered with thousands of miles of an amazingly complex network of drainage ditches. Channelization efforts typically lead to a reduction in overall stream miles, however, in the MAB ditching and draining efforts have led to a dramatic increase in the mileage of stream channels. The actual increase in miles of channel is unknown, however, historic maps of the Subregion show very few stream channels—certainly nothing close to what exists today.

Average annual runoff ranges from 18 to 20 inches, which is the highest in the state. However, the nearly flat topography of the MAB results in low runoff rates and the sand and gravel alluvial deposits that overlay the relatively impermeable clayey subsoils make excellent shallow aquifers (Pflieger 1971). These two factors are collectively responsible for the relatively stable hydrographs and high baseflow potential of streams and ditches within the MAB where even the smallest channels tend to carry water during the driest periods of the year. Data from four long-term USGS gaging stations in Table 1 (1 from MO, 3 from AR) illustrate the influence of shallow alluvial aquifers on the hydrologic regimes of streams and ditches that drain this highly altered landscape. The average 10:90 ratio for these four rivers is just 29 and the unit discharges for 90% exceedence flows range from 0.12 to 1.5 cfs per square mile (see Table 1). Values for these measures of flow stability and baseflow potential are much more similar to streams within the Ozarks than those in the Central Plains. Also, the average of the unit discharges for peak flows in the MAB is merely 20 cfs per square mile which is considerably lower than averages for the Central Plains (63) and the Ozarks (120) and depicts the relatively low rates of surface runoff for this Subregion even during periods of intense rainfall (see Table 1).

Basic water chemistry in the MAB is similar to streams draining the Salem Plateau within the Ozarks. Waters are principally calcium magnesium bicarbonate and exhibit dissolved concentrations between 140 and 170 mg/L (Adamski et al. 1995). As part of the USGS National Water Quality Assessment (NAWQA) program, Kleiss et al. (2000) conducted a water quality assessment of the Mississippi Embayment, which largely corresponds with the boundaries MAB. Their study found herbicide and pesticide concentrations to be relatively high in the ditches and streams draining this Subregion. Insecticide concentrations were also fairly high near urban areas. Nitrogen concentrations were generally in the middle of the range of national data, whereas phosphorous concentrations were in the 67th to 93rd percentile of other study units examined across the Nation. Nutrients entering the mainstem generally cause few water quality problems because of buffering and dilution (Boone 2001). Enrichment in many of the smaller ditches, however, can cause extreme turbidities, excessive growth of aquatic plants, and low dissolved oxygen concentrations, which can cause localized fish kills during summer low flow periods (MDNR 1984). The organochlorine insecticide DDT, or one of its metabolites, was found in every fish tissue sample, 67% of the

streambed-sediment samples, but only 14% of the surface-water samples. Unlike surface waters, groundwater quality was generally quite good. This is likely the result of the thick confining layers of clay within this Subregion, which generally isolate the groundwater from surface activities (Kleiss et al. 2000).

Despite the seemingly homogenous character of the MAB landscape, the ditches and few remaining natural streams in the Subregion vary substantially in terms of discharge, turbidity, current, substrates, aquatic vegetation and shading by riparian vegetation (Pflieger 1971). Smaller ditches are most variable in character, but generally have higher water clarity than larger ditches. Some have no perceptible current during base flow with bottoms comprised mainly of silt while others are fairly swift and have bottoms mostly comprised of sand and small gravel (Pflieger 1989). Channels with clear water and little riparian shading are generally choked with submergent vegetation. Some of the major ditches are large enough to be classified as either small or large rivers. These ditches are extremely wide and shallow with considerable current throughout. Channel gradients are significantly lower in the MAB than the other two Subregions (see Figure 5). Channels classified as headwaters have an overall average gradient of 2.6 m/Km, while the average gradient of channels falling within all other sizes classes are less, and often substantially less, than 1 m/Km. Despite these low stream gradients headcutting and rill and gully erosion are substantial problems upstream from channelized sections (Boone 2001). Cover is generally sparse and is often confined to undercut banks and associated vegetation or woody debris. Woody cover is typically much more abundant in unchannelized stream sections (Boone 2001).

The small streams draining Crowley's Ridge have hydrologic and instream habitat conditions similar to those found in some streams within the Ozarks. Streams are relatively clear with sand and gravel substrates and occasional bedrock exposures. Seeps and springs are common and many of the smallest channels are either intermittent or completely dry during base flow periods.

Biota

The aquatic fauna of the MAB Subregion is not nearly as diverse as the Ozarks, but no less distinctive (Pflieger 1996; 1997). A total of 172 species (128 fish, 34 mussels, and 10 crayfish) inhabit the streams and ditches of this Subregion. While only five of these species are endemic to the MAB, thirty species of fish and crayfish are either confined or occur only occasionally elsewhere in Missouri. Many of these species are characteristic of the Gulf Coastal Plain of the southern United States and reach the northern limit of their range in MAB Subergion of southeast Missouri (Pflieger 1996; 1997).

The 128 fish species represent 23 different families with the most dominant small fishes being minnows (Cyprinidae) and darters (Percidae). There is really no single group of large fishes that are dominant in the MAB (Pflieger 1996). Only two of these fish species, the bantam sunfish (*Lepomis symmetricus*) and the sabine shiner (*Notropis*

sabinae), are endemic to the MAB. One species, the pallid sturgeon (*Scaphirhynchus albus*), is classified as globally endangered while 23 are listed as state threatened or endangered. All of the 34 mussel species of the MAB fall within the family Unionidae and one of three subfamilies, Ambleminae, Lampsilinae, and Anodontinae. No mussel species are endemic to the MAB and the western fanshell (*Cyprogenia aberti*) is the only globally listed species (threatened) by NatureServe's natural heritage network. Five species are listed as state threatened or endangered.

The MAB supports a small but distinctive crayfish fauna of 10 species (Pflieger 1996). The genera Orconectes and Cambarus, which dominate the Ozark fauna, are represented by only two and one species, respectively in the MAB. There are three species of Procambarus, two species of Cambarellus, and one species each of Fallicambarus and Faxonella (Pflieger 1996). The most common and widespread species are the devil (*Cambarus diogenes*), gray-speckled (*Orconectes palmeri*), red swamp (*Procambarus clarkii*), and Shufeldt's dwarf (*Cambarellus shufeldtii*) crayfish. Only the shrimp (*Orconectes lancifer*) and vernal (*Procambarus viaeviridis*) crayfish are endemic to the MAB. No species are listed as globally threatened or endangered while the digger (*Fallicambarus fodiens*), shrimp, and shield (*Faxonella clypeata*) crayfish are state listed as threatened.

APPENDIX 3.2
Descriptions of the Ecological Drainage Units (EDU) in Missouri

Central Plains Aquatic Subregion

Blackwater/Lamine EDU

The Blackwater/Lamine EDU lies in westcentral Missouri. Overall there are 13,841 km of primary stream channel within this EDU, of which 3,819 km are classified as perennial in the 1:100,000 National Hydrography Dataset (Figure 1).

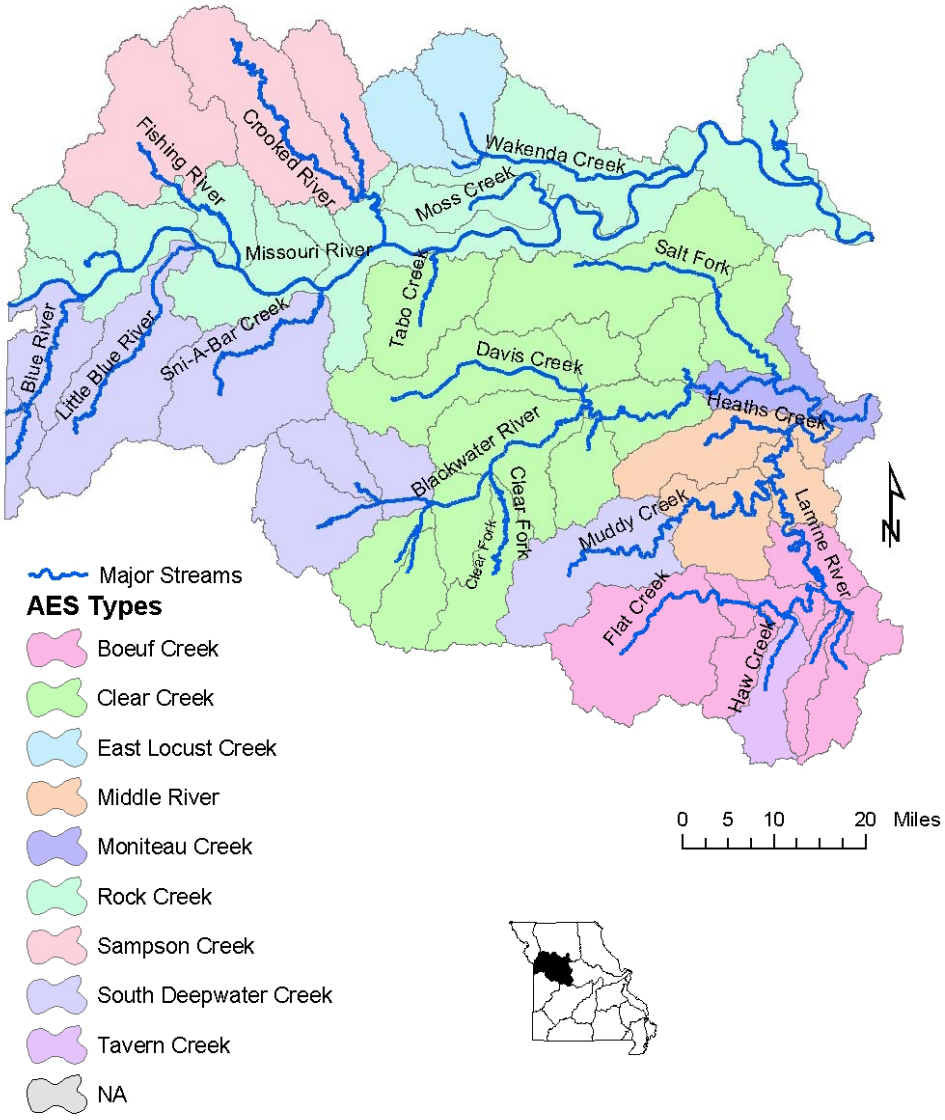


Figure 1. Map showing the boundaries and various Aquatic Ecological System Types for the Blackwater/Lamine Ecological Drainage Unit.

This EDU contains an amazingly diverse landscape since it straddles the boundary between the Central Dissected Till Plains and the Ozarks and also borders the Missouri River. The majority of the EDU falls along the southeastern margin of the Central Dissected Till Plains Ecological Section as described by Bailey (1995), but also includes unglaciated sections of the Blackwater and Lamine drainages that are often labled as Ozark Border. Most streams within this EDU originate on level uplands underlain by Pennsylvania shales and then descend into more rugged terrain underlain by Ordovician limestones. Within the Central Dissected Till Plains, which straddles the Missouri River within this EDU, the landscape is covered with thick to very thick loess deposits. Pennsylvanian shales, thin-bedded limestones, and some sandstone and coal deposits lie underneath the thick loess and glacial deposits and generally have little influence on surface features. Soils are primarily silty and clayey loams with moderate infiltration rates. Local relief ranges from 0 within the floodplains of the Missouri River to 50-250 feet in the uplands. Streams that are south of the Missouri River and east of the Lamine River (e.g., Gabriel and Richland Creeks) are cutting through older Mississippian limestones and dolomites throughout most their length. Relief in this region is generally 100-200 feet.

The average gradient across all stream size classes is 7.4 m/km. Average gradients (m/km) by size class are: headwater 10.5, creek, 2.5, small river 0.8, and large river 0.2. Streams in the west of this EDU are generally surface water dominated, turbid with sand and silt substrates. Streams in the south and east are clear, gravelly, and approach Ozark streams in character. There are 9 AES-Types in this EDU, which is by far the highest number for any EDU in the Central Plains (Figure 1). Differences among the AES-Types relate to all of the major landscape controls on stream ecosystem structure and function; geology, soils, relief, and groundwater influence.

Historically this EDU was mainly covered in tallgrass prairie in the west that graded into oak savanna and woodlands on the steeper areas and valleys. Marshes and bottomland forest were also common in these areas. Today this area is dominated by a mixture of cropland in the bottomlands and the high flat ridgetops and pasture within the more hilly regions. In the east, this EDU was mainly in timber ranging from oak savannas on the broad uplands to open-oak woodlands, to dense oak and mixed-hardwood species in the more dissected areas that bordered the Missouri River. Today this area of the EDU is largely covered in second-growth oak and mixed hardwood forests. Cropland also occupies much of the Lamine River bottoms. Some of the principle management concerns include; erosion/sedimentation, channelization, lack of riparian vegetation, runoff from abandoned coal mines, excessive nutrient loads, CAFOs, and high temperatures/low dissolved oxygen.

A total of 96 fish, 29 mussels, and 5 crayfish either inhabit or at one time inhabited the Blackwater/Lamine EDU. According to the Missouri Natural Heritage Program there are 7 globally listed (rare, threatened, or endangered) species and 20 state listed species. The fish assemblage is characterized by a distinct mix of species characteristic of the Central Plains, Ozarks, and the Missouri River. Characteristic fish species include the largemouth bass, green sunfish, common shiner, Topeka shiner, blacknose shiner, pallid sturgeon, plains killifish, black bullhead, golden redhorse, and western silvery minnow. Characteristic mussel species include the ellipse, flat floater, and wartyback. Characteristic crayfish species include the grassland and papershell.

Nishnabotna/Platte EDU

The Nishnabotna/Platte EDU lies mainly in northwest Missouri and southwest Iowa, but also covers a small portion of eastern Kansas and Nebraska (Figure 2). Overall there are 23,952 km of primary stream channel within this EDU, of which 8,188 km are classified as perennial in the 1:100,000 National Hydrography Dataset. Of the total, 8,088 km (34%) falls within Missouri. Within Missouri, only one percent of the EDU is within public ownership.

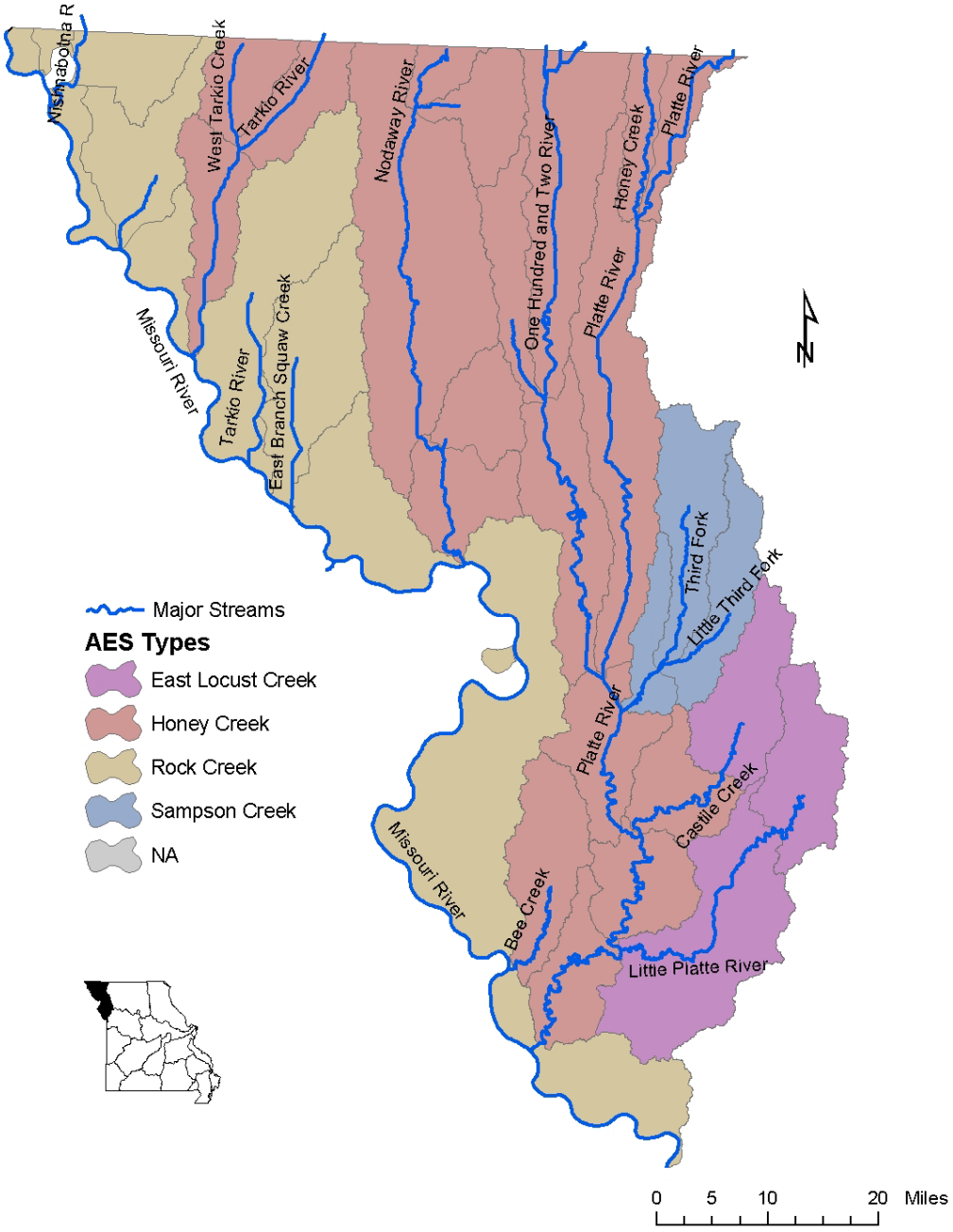


Figure 2. Map showing the boundaries and various Aquatic Ecological System Types for the Nishnabotna/Platte Ecological Drainage Unit.

This EDU is entirely contained within the Central Dissected Till Plains Ecological Section as described by Bailey (1995). The most characteristic feature of this EDU is the thick to very thick loess deposits that occur in the western and central sections. Pennsylvanian shales, thin-bedded limestones, and some sandstone and coal deposits lie underneath the thick loess and glacial deposits and generally have little influence on surface features. Soils are primarily silty and clayey loams with moderate infiltration rates. Local relief ranges from 0 within the floodplains of the Missouri River to 50-250 feet in the uplands. Some streams occupy narrow, steep-sided, valleys while others occupy extremely wide valleys, which reflect the glacial history of the area.

The average gradient across all stream size classes is 7.9 m/km. Average gradients (m/km) by size class are: headwater 11.7, creek, 2.5, small river 0.8, and large river 0.4. Streams are surface-water dominated, and springs are extremely rare and those that do exist have minimal discharge and many are saline. Riffle habitats are rare and often completely absent. Streams are also very turbid with substrates of mainly sand and silt. There are four different Aquatic Ecological System Types (AES-Types) found within the Nishnabotna/Platte EDU, which differ mainly in terms of soil and relief characteristics (Figure 2). The Honey Creek AES-Type dominates the landscape and lies in the central and northern portion of the EDU. The Rock Creek AES-Type is the second most prevalent and runs the entire western border of the EDU. The Locust Creek and Sampson Creek AES-Types represent isolated occurrences of the landscapes that dominate the neighboring Grand/Chariton EDU.

Historically this EDU was mainly covered in prairie, including the unique dry loess hill prairies that occurred in the extreme northwestern corner of Missouri. Oak savanna and woodlands generally occupied the steeper areas and valleys. Marshes and bottomland forest were also common. In addition, bottomland prairies were present in some areas. Today this EDU is an agricultural landscape. Cropland occupies most alluvial plains and the less dissected uplands, while nonnative, cool-season, pasture occupies the more rugged lands. Some of the principle management concerns include; erosion/sedimentation, channelization, lack of riparian vegetation, abandoned coal mine runoff, excessive nutrient loads, CAFOs, high temperatures and low dissolved oxygen.

A total of 71 fish, 23 mussels, and 4 crayfish either occur or historically occurred within this EDU. Unfortunately, a fair number of these 98 species have likely been locally extirpated (e.g., common shiner, Topeka shiner, hornyhead chub, and johnny darter). According to the Missouri Natural Heritage Program there are 5 globally listed (rare, threatened, or endangered) species and 16 state listed species. The fish assemblage is characterized by wide-ranging, tolerant, species and could generally be classified according to the dominant families as a Minnow/Sucker/Catfish assemblage. The most characteristic fish species is the red shiner. Characteristic mussel species include the flat floater and the rock pocketbook, while the grassland and papershell are characteristic crayfish.

Grand/Chariton EDU

The Grand/Chariton EDU lies northcentral Missouri and southcentral Iowa (Figure 3). Overall there are 26,964 km of primary stream channel within this EDU, of which 7,338 km are classified as perennial in the 1:100,000 National Hydrography Dataset. Of the total, 20,690 km (77%) falls within Missouri.

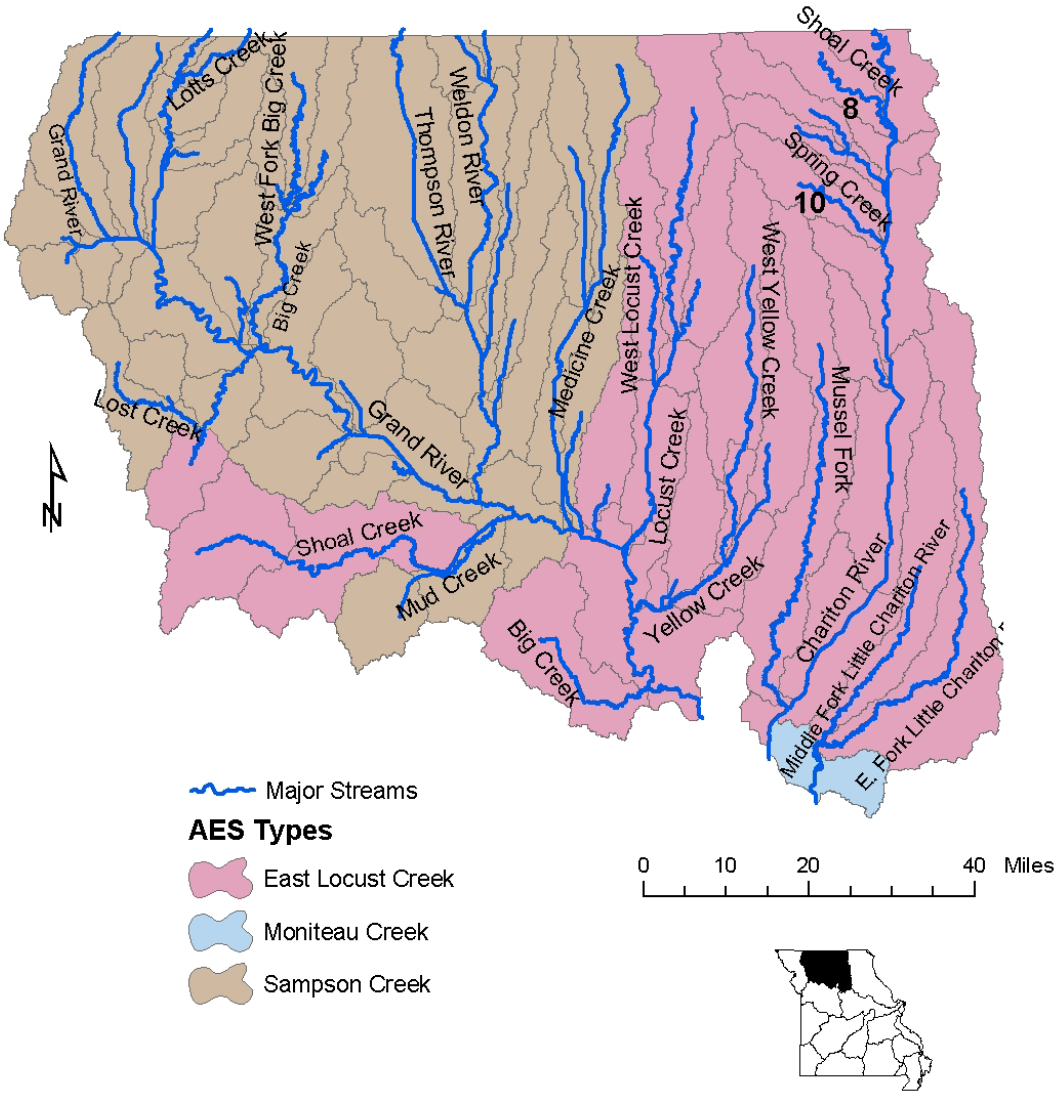


Figure 3. Map showing the boundaries and various Aquatic Ecological System Types for the Grand/Chariton Ecological Drainage Unit.

This EDU is entirely contained within the Central Dissected Till Plains Ecological Section as described by Bailey (1995). The most characteristic feature of this EDU is the presence of pre-illinoisian glacial till covered with a thin veneer of loess. Pennsylvanian shales, thin-bedded limestones, and some sandstone and coal deposits are the dominant bedrock features. Soils vary considerably across the EDU and relate to differences in vegetation under which the soils formed, the parent materials and position on the landscape. Soil surface textures consist of mainly of clay loams and loams with slow to moderate infiltration rates. Soils closest to the stream channels are the sandiest with fairly high infiltration rates,

while soils further from the streams contain more clay and exhibit slower infiltrations. Local relief generally ranges from 50 to 150 feet, but increases from west to east where in the Chariton River Hills relief of 200-250 is locally common. Stream valleys tend to be fairly wide for the size of the streams associated with them and some areas exhibit very little stream dissection.

The average gradient across all stream size classes is 7.0 m/km. Average gradients (m/km) by size class are: headwater 10.5, creek, 2.0, small river 0.7, and large river 0.4. Streams are surface-water dominated, and springs are extremely rare and those that do exist have minimal discharge and many are saline. Riffle habitats are rare and generally only occur where the streams have cut through the glacial till to underlying sedimentary bedrocks. These sections of streams are also often running across the exposed bedrock. Streams are also very turbid with substrates of mainly sand and silt. There are three different Aquatic Ecological System Types (AES-Types) found within the Grand/Chariton EDU, which differ mainly in terms of soil, relief, and historic vegatation characteristics (Figure 3). The Sampson Creek AES-Type dominates the landscape and lies in the western portion of the EDU. The East Locust Creek AES-Type is the second most prevalent and covers the eastern portion of the EDU. Only a single example of the Moniteau Creek AES-Type occurs in the EDU right at the outlet of the Little Chariton River. This isolated type reflects the relatively abrupt collective change in soils, geology, and relief that occurs along the transition between the Central Plains and the Ozarks.

Historically this EDU was mainly covered in tallgrass prairie. Oak savanna and woodlands generally occupied the steeper areas and valleys. Marshes and bottomland forest were also common. In addition, bottomland prairies were present in some areas. A notable feature, however, was the more heavily forested region that occurred in the upper portions of the Chariton and Little Chariton River watersheds. These areas represented one of the most complex mosaics of prairie, savanna, woodland, and foreset in Missouri. Today this EDU is dominated by fescue and brome pasture. Cropland occupies most of the larger river valleys and broader uplands. Some of the principle management concerns include; erosion/sedimentation, channelization, runoff from abandoned coal mines, excessive nutrient loads, CAFOs, elevated temperatures, and decreases in dissolved oxygen.

A total of 68 fish, 23 mussels, and 5 crayfish either inhabit or at one time inhabited the Grand/Chariton EDU. According to the Missouri Natural Heritage Program there are 2 globally listed (rare, threatened, or endangered) species and 13 state listed species. The fish assemblage is characterized by wide-ranging, tolerant, species and could generally be classified according to the dominant families as a Minnow/Sucker/Catfish assemblage. The most common species include the channel catfish, black bullhead, yellow bullhead, common carp, river carpsucker, creek chub, red shiner, sand shiner and green sunfish. The flat floater is a characteristic mussel species, while the grassland and papershell are characteristic crayfish.

Cuivre/Salt EDU

The Cuivre/Salt EDU lies mainly in northeastern Missouri, but also covers portions of western Illinois and southeastern Iowa (Figure 4). Overall there are 24,617 km of primary stream channel within this EDU, of which 8,148 km are classified as perennial in the 1:100,000 National Hydrography Dataset. Of the total, 18,891 km (77%) falls within Missouri.

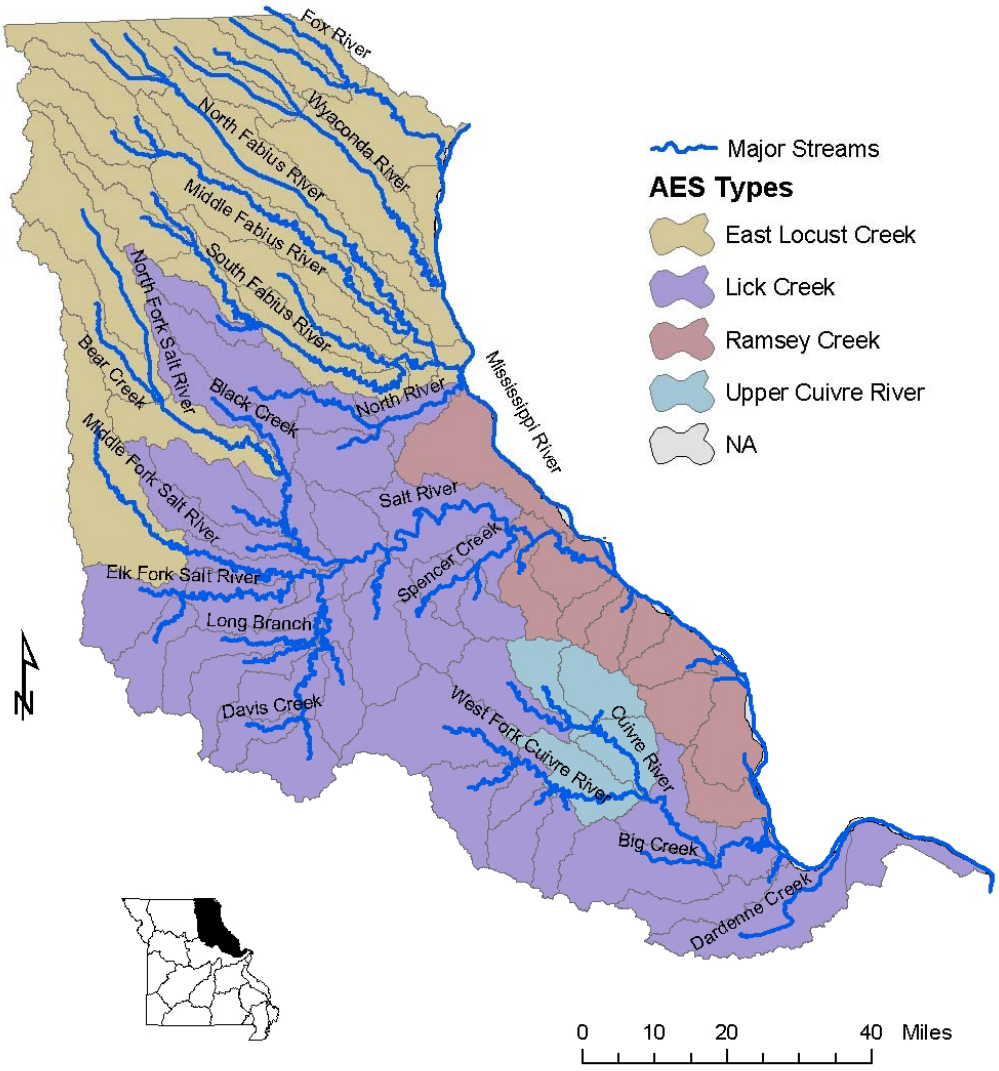


Figure 4. Map showing the boundaries and various Aquatic Ecological System Types for the Cuivre/Salt Ecological Drainage Unit.

This EDU drains the eastern margin of the Central Dissected Till Plains Ecological Section as described by Bailey (1995). The level, undissected, uplands in the western portion of the drainage are underlain mainly by horizontally bedded MS and PN shales, while the more hilly and dissected topography to the east is underlain principally by Ordovician limestones and sandstones. A distinctive feature of this EDU is the “claypan region”, which covers most of the west/southwest portion of the EDU. This region is a very flat plain underlain by claypan soils that have resisted postglacial stream erosion. Local relief in this region is generally less than 100 feet. Soils are deep and poorly drained and harbor a perched water

table in the winter and spring as a result of the claypan subsoils. Soil surface textures are mainly silty loams.

The average gradient across all stream size classes is 6.5 m/km. Average gradients (m/km) by size class are: headwater 9.4, creek, 2.6, small river 0.8, and large river 0.3. Streams in the west and north of this EDU are generally surface water dominated, turbid with sand and silt substrates. Streams in the south and east are clear, gravelly, and approach Ozark streams in character with springs locally abundant. There 4 AES-Types in this EDU. The Lick Creek AES-Type largely corresponds with the Claypan Region. The Locust Creek AES-Type covers the northern third of the EDU. The Ramsey Creek AES-Type represents those streams and watersheds that border the Mississippi River and are underlain by Ordovician limestones. Finally, the Upper Cuivre River AES-Type is similar to the Ramsey Creek type, but here springs are locally abundant and significantally alter thermal and hydrologic regimes such that the streams are very Ozark in character.

Historically this EDU was mainly covered in tallgrass prairie in the west and north that graded into oak savanna and woodlands on the steeper areas and valleys. Marshes and bottomland forest were also common in these areas. Today this area is dominated by cropland in the claypan region and pasture in the north. In the south and east this EDU was mainly in timber ranging from oak savannas on the broad uplands to open- and dense oak woodlands and mixed-hardwood species in the more dissected areas. Today this area of the EDU is largely covered in second-growth oak and mixed hardwood forests. Cropland occupies most of the larger river valleys and broader uplands. Some of the principle management concerns include; erosion/sedimentation, channelization, lack of riparian vegetation, fragmentation and innundation by Mark Twain Reservoir, runoff from abandoned coal mines, excessive nutrient loads, CAFOs, and high temperatures/low dissolved oxygen.

This is the most biologically diverse EDU in the Central Plains Aquatic Subregion. A total of 117 fish, 42 mussels, and 6 crayfish either inhabit or at one time inhabited the Grand/Chariton EDU. According to the Missouri Natural Heritage Program there are 10 globally listed (rare, threatened, or endangered) species and 26 state listed species. The fish assemblage is characterized by a distinct mix of species characteristic of the Central Plains, Ozarks, and Mississippi Alluvial Basin. In general, the fish assemblage could be classified according to the dominant families as a Minnow/Darter/Sunfish assemblage. The red shiner and bluntnose minnow are two of the more common species encountered in this EDU, however, several other species (too many to list) are also commonly encountered. Characteristic mussel species include the flat floater, pink mucket, rabbitsfoot, and spectaclecase. Characteristic crayfish species include the grassland, papershell, and Shufeldt’s dwarf.

Osage/South Grand EDU

The Osage/South Grand EDU lies in eastern Kansas and westcentral Missouri and is largely coextensive with the Osage Plains Ecological Section, except for the extreme eastern edge, which straddles the boundary of the Osage Plains and the Ozarks (Bailey 1995) (Figure 5). Overall there are 21,250 Km of primary stream channel within this EDU, of which 5,770 Km are classified as perennial in the National Hydrography Dataset. Of this total 9,728 Km (46%) falls within Missouri.

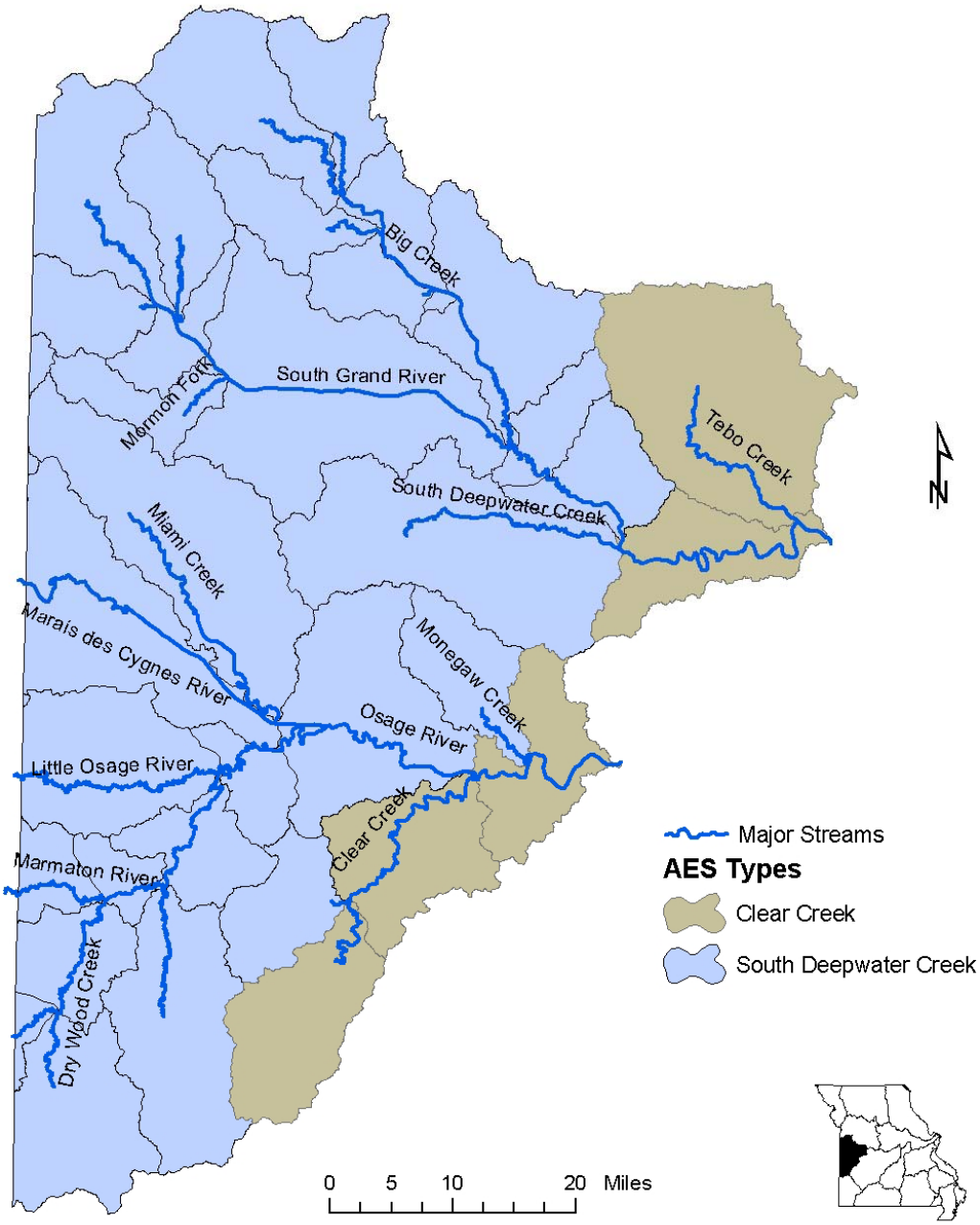


Figure 5. Map showing the boundaries and various Aquatic Ecological System Types for the Osage/South Grand Ecological Drainage Unit.

The landscape of this EDU can be generally broken into two distinct regions, the Osage Plains and the Ozark Border. The Osage Plains is mainly underlain by Pennsylvanian deposits that are overlain by upto 6 feet of loess. The lithology consists of alternating beds of limestone, sandstone, shale and coal. The sandstone and shale impeed downward water movement, making for poor aquifers, which results in these streams being largely surface water dominated. As a result, most of the smaller streams are ephemeral or intermittent. Even the largest streams have extremely low discharges during extended dry periods. Topography is gently rolling, with relief generally in the range of 100-150 feet within the northwest trending limestone escarpments, and 50 feet in the interceeding regions, which are dominated by shale. Streams occupy broad, shallow valleys, that slope gradually into the flat to gently rolling uplands. Stream channels are highly meandering, entrenched, with extremely low gradients (although channels running off the escarpments have relatively high gradients) Waters are generally turbid and substrates mainly sand and silt, with riffles poorly defined or often completely absent, but when present contain slate-like pieces of shale and sandstone embedded in fines. Bedrock is intermittently exposed in some of the smaller streams. Oxbow lakes, sloughs and marshes were once common along the largest streams.

The Ozark Border lands on the eastern edge of this EDU are mainly underlain by Pennsylvanian geologic deposits, interspersed with Mississippian deposits that contain higher percentages of limestone, which may or may not be covered with a thin veneer of loess. Like the western portion of the EDU the lithology consists of an interspersion of limestone, sandstone, shale and coal beds, but here limestone and coal comprise a higher percentage. This higher percentage of limestone results in slightly higher groundwater contributions to streams within this region. Most of the smaller streams are still ephemeral or intermittent, but springs become slightly more abundant. Topography is gently rolling and less variable than the western portion with relief generally in the range of 100-150 feet. Streams are more straight, less entrenched, with higher gradients. Waters are less turbid and substrates are varied with gravel and sand dominating, but larger substrates are present. Riffles become more common and more clearly defined. Pools adjacent to the valley wall often contain boulders and large slate fragments.

The average gradient across all stream size classes is 6.3 m/Km. Average gradients (m/Km) by size class are: headwater 8.8, creek, 2.1, small river 0.6, and large river 0.2. Springs are extremely rare and those that do exist have minimal discharge and many are saline. Not suprisingly, there are no coldwater streams within this EDU. There are only two distinct Aquatic Ecological System Types (AES-Types) are found within the Osage/South Grand EDU (Figure 5). The South Deepwater Creek AES-Type covers most of the EDU and essentially follows the boundary of the Osage Plains. The Clear Creek AES-Type occupies the eastern edge of the EDU and represents those transitional lands along the boundary of the Osage Plains and the Ozarks.

Historically the Osage Plains portion of this EDU was 80% prairie, mostly tallgrass prairie. Oak savanna and woodlands occupied the steeper scarped areas and valleys, while marshes and bottomland forest were common along the major streams. Today this area is primarily an agricultural landscape (80%), with 60% being pasture. Those lands along the Ozark Border were historically a mixture of prairie and Oak/Savanna with Oak/Hickory forest in the steeper areas and along the stream channels. This region is currently less

permanently converted than the western portion of the EDU, however, most savanna lands have been lost.

Water quality problems are common throughout the EDU mainly due to point source problems associated with municipal sewage treatment effluents and non-point source problems associated with agricultural and mining activities. Stream problems in the basin include: water quality degradation due to cattle in virtually all basins; acid runoff from unreclaimed strip mines in the Clear Creek, Monegaw, Marais des Cygnes, and Drywood subbasins; inadequate riparian corridors, erosion and sedimentation caused by channelization and agricultural runoff; maintenance of already low base flows; threats to base flows by future watershed developments (especially in Kansas which has plans for developing over 60% of the Marmaton River watershed); extensive impoundments and channelization in some subbasins; introduction of non-native species, especially in Kansas with the stocking of sportfish into state lakes and Corps of Engineers impoundments; limited access on selected streams; and a general lack of public knowledge of problems in the basin. Many of these problems are complicated by the high proportion (60%) of the basin that occurs in Kansas. Interagency cooperation between Missouri and Kansas will be a key to the successful implementation of this management plan.

Most distinctive characteristic of this EDU is the limited fauna it contains relative to other EDUs in the state. A total of 81 fish, 26 mussels, and 6 crayfish either inhabit or at one time inhabited this EDU. According to the Missouri Natural Heritage database there are 2 globally listed (rare, threatened, or endangered) species and 8 state listed species. The fauna within those streams draining the Osage Plains is characterized by highly tolerant, wide-ranging, species. Within the streams draining the Ozark Border, intolerant Ozark species become more common and abundant (e.g., rosyface shiner, hornyhead chub, slender madtom, longear sunfish, and slenderhead darter). Common crayfish species include the grassland and papershell crayfish. Common mussels include the ellipse and black sandshell.

Ozark Aquatic Subregion

Apple/Joachim EDU

The Apple/Joachim EDU lies in eastcentral Missouri and westcentral Illinois. It includes all of the smaller direct tributaries to the Mississippi River between the outlets of the Missouri and Ohio Rivers (Figure 6). The EDU is entirely within the Ozark Highlands as described by Bailey (1995), but reprents the northeastern boundary of this ecoregion. Overall there are 7,166 km of primary stream channel within this EDU, of which 2,791 km are classified as perennial in the 1:100,000 National Hydrography Dataset. A little over half of the EDU is within Missouri (3,938 km, 55%).

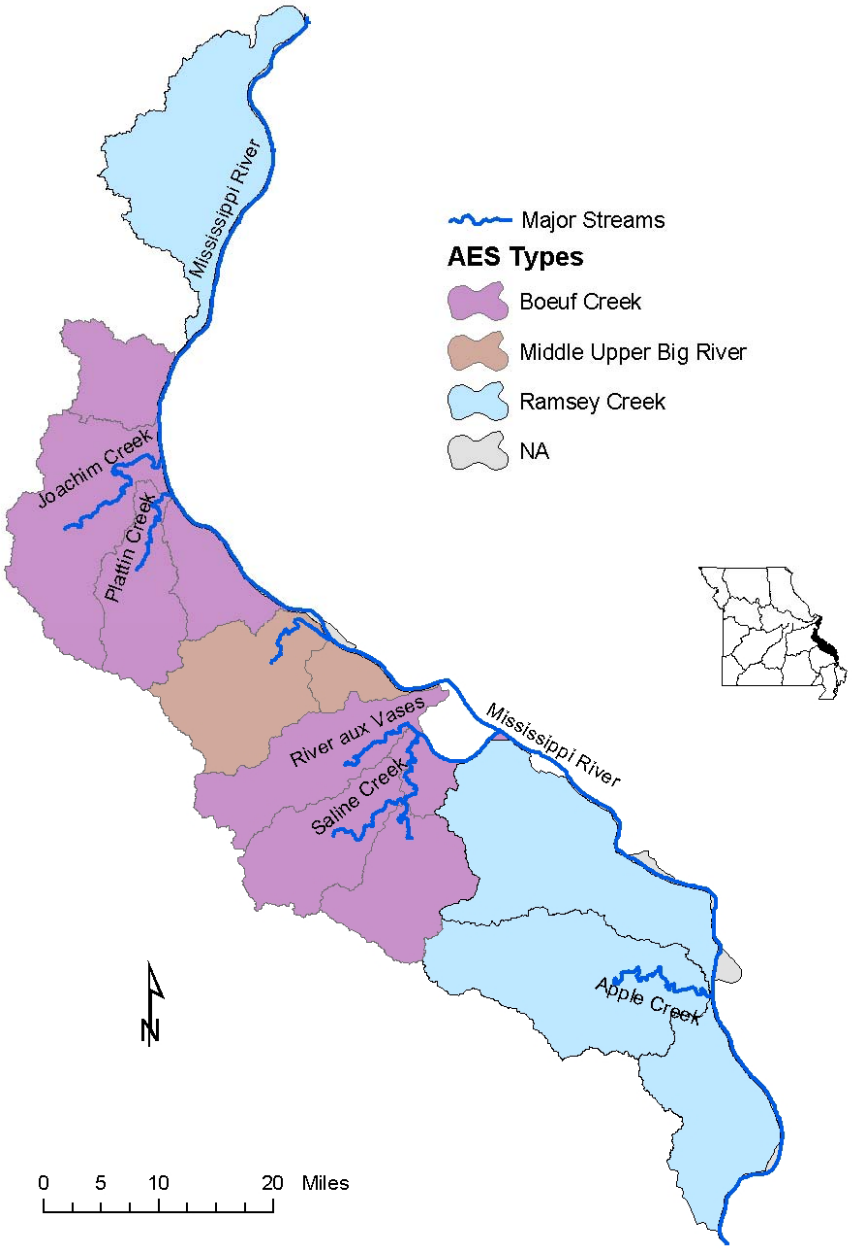


Figure 6. Map showing the boundaries and various Aquatic Ecological System Types for the Apple/Joachim Ecological Drainage Unit.

Within Missouri, the Inner and Outer Ozark Border Ecological Subsections dominate the landscape of this EDU. These two subsections differ mainly in terms of bedrock geology and relief. The Outer Ozark Border, as it runs along the Mississippi River, generally has lower relief (150 feet) and is underlain by Mississippian limstones, which corresponds with the distributional limit of many Ozark aquatic species. The Inner Ozark Border has higher relief (150-300 feet) and is underlain by Ordovician dolomites. There are three Aquatic Ecological System Types (AES-Types) within this EDU (Figure 6). The boundaries of these AES-Types generally correspond with the major Ecological Subsections just discussed.

The average gradient across all stream size classes is 14 m/km. Average gradients (m/km) by size class are: headwater 17.5, creek, 3.8, and small river 0.9. There are no streams classified as large river within this EDU. This EDU has a hydrologically diverse landscape with an equal mixture of surface water and springflow-dominated streams. Riffle habitats are common in all streams, but decrease in occurrence as the channels approach the Mississippi River and eventually become asbsent once the channels enter the floodplain of this great river. Some of the principle management concerns include; nonpoint source pollution (erosion/sedimentation and organic wastes), overgrazing, gravel and lead mining, removal and fragmentation of riparian vegetation, altered thermal regimes, roads and bridges, and industrial and municpal effluents.

A total of 121 fish, 23 mussels, and 5 crayfish either inhabit or at one time inhabited the Moreau/Loutre EDU. According to the Missouri Natural Heritage Program there are 8 globally listed (rare, threatened, or endangered) species and 19 state listed species. The fish assemblage is characterized by a mixture Ozark, Great River, and Lowland species and could be classified according to the dominant families as a Minnow/Darter/Sucker assemblage. Distinctive fish species include the Ozark minnow, Mississippi silvery minnow, bleeding shiner, western sand shiner, ghost shiner, crystal darter, sicklefin chub, sturgeon chub, pallid sturgeon, lake sturgeon, and Alabama shad. A distinctive feature of this EDU is the prevalence of Great River species in the lower sections of the major tributaries.

The most common mussel species are the giant floater, pondmussel, and fatmucket. The flat floater is a distinctive mussel species. The virile, spothanded, devil, and golden are the most common and distinctive crayfish species.

Black/Current EDU

The Black/Current EDU lies in southcentral Missouri and northcentral Arkansas (Figure 7). It covers those portions of the Black, Current, and Eleven Point watersheds that fall within the Ozark Highlands as described by Bailey (1995). Overall there are 17,899 km of primary stream channel within this EDU, of which 3,642 km are classified as perennial in the 1:100,000 National Hydrography Dataset. Most of the EDU (14,376 km, 80%) is within Missouri. It is the most physiographically, hydrologically, and biologically diverse EDU in the state. The EDU contains the entire Current River Hills Subsection and portions of three other subsections; Central Plateau, Black River Ozark Border, and the St. Francois Knobs and Basins.

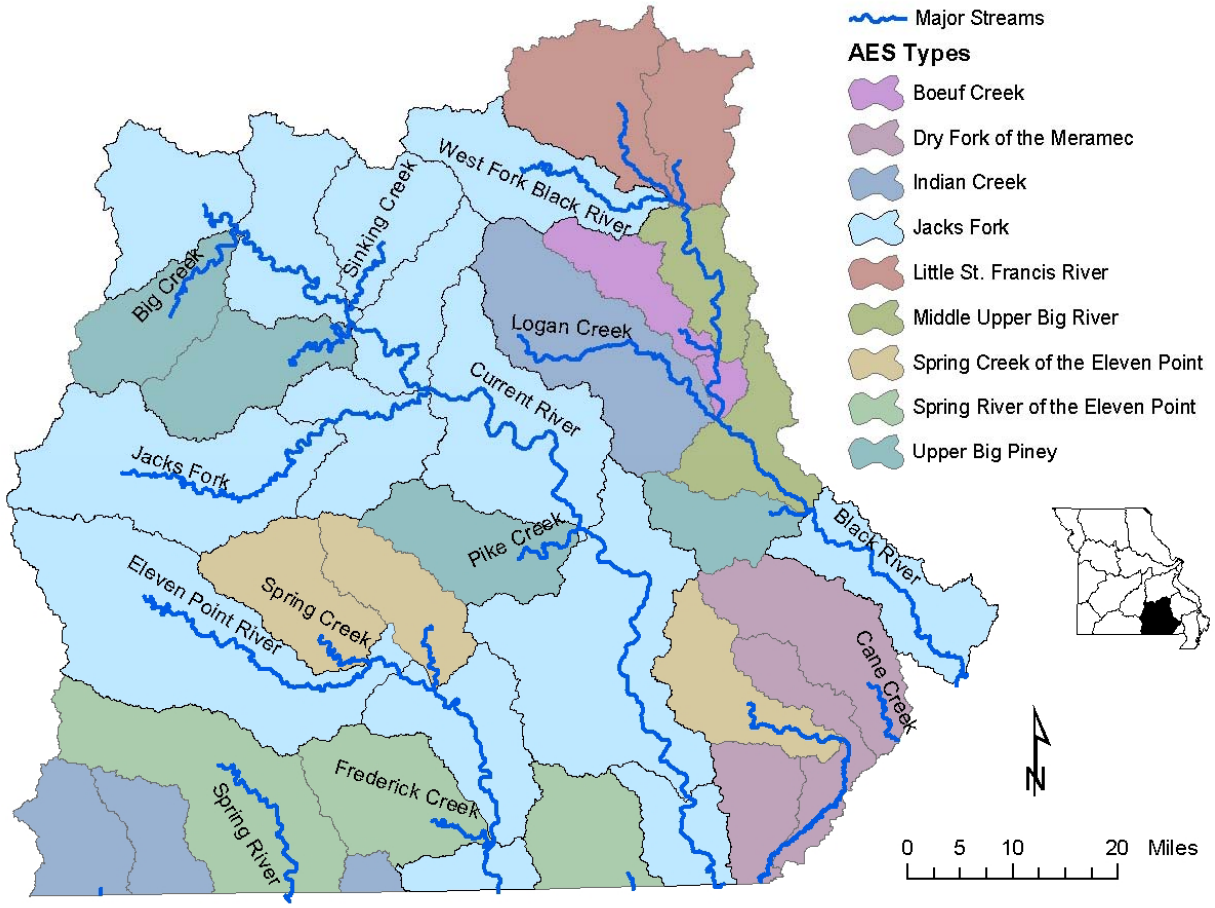


Figure 7. Map showing the boundaries and various Aquatic Ecological System Types for the Black/Current Ecological Drainage Unit.

The Central Plateau Subsection, which dominates the Eleven Point River watershed, consists of some of the least dissected portions of the Ozark Highlands. It is dominated by a thick carobnate geology consisting mainly of cherty dolomites and some prominent sandstone components, all of Ordovician age. Soils consist of cherty or silty loam with moderate to slow infiltration rates. Fragipans are widespread in the subsoil. Relief in this portion of the EDU is generally 50-150 feet. Floodplains tend to be narrow and not extensive, with very gravelly soils. This area is minimally dissected and many of the

streams are either ephemeral or intermittent. Stream gradients are relatively low compared to the rest of the EDU with correspondingly smaller substrates of silt, sand, and gravel. Mainly small springs are common in this low relief landscape. This area was historically covered in a diverse mosaic of prairie, savanna, and open oak woodlands. Today it is largely covered in pasture and second growth timber.

The Current River Hills is a deeply dissected landscape with steep slopes, narrow ridges, and narrow valley bottoms. Most of this subsection is underlain by thick, cherty dolomites, and sanstones of the Gasconade and Roubidoux formations of the early Ordovician. The high, genetly rolling, dissected plains and hills are underlain mainly by resistant sandstones and dolomites of the Roubidoux Formation. More deeply dissected lands cut into the dolomites of the Gasonade Formation and the deepest valleys cut into the Cambrian Eminence-Potosi Formation. Weathering of the highly soluable dolomites has produced the karst landscape that dominates this subsection, including numerous large springs, losing streams, sinkholes and cave. Soils are formed in weathered bedrock and rock fragments are numerous. Surface soil textures consist of cherty soils and silt loams with moderate to slow infiltration rates. Relief is relatively high, ranging from 200-600 feet. Streams are very clear with extremely high gradients and gravel and cobble substrates. Extensive gravel bars are quite common within the active stream channel. Riffles and bluff pool habitats are abundant. Historically, this area contained a diverse mosaic of vegetation. It is best known for the extensive shortleaf pine-oak forests and woodlands that once covered this region. Unique igneous knobs and glades also occur in the central Current River Valley. Today the region is still mainly forested, except for pasture bottomlands. Shortleaf pine is much less abundant and most glades have been overgrown by eastern red cedar. Despite these changes a significant portion of this landscape is still in native vegetation.

The northeastern corner of the Black River watershed falls within the St. Francois Knobs and Basins Subsection. The presence of exposed Precambrian bedrock and tremendously high relief (400-1,000 feet) make this portion of the EDU distinct. Before exiting the state the Current and Black Rivers cut through a transition zone known as the Black River Ozark Border. This landscape is quite similar to that of the Central Plateau, but has a slightly higher relief (300 feet). As streams approach the Ozark Escarpment their gradients decrease dramatically and the percentage of fine substrates increases, with silt often becoming dominant.

The average gradient across all stream size classes is 13.6 m/km. Average gradients (m/km) by size class are: headwater 18, creek, 4.4, small river 1.6, and large river 0.8. Streams are largely surface-water dominated within the Central Plateau and Ozark Border Subsections with scattered small spring inputs, while streams in the remainder of the EDU are largely dominated by springflow. Riffle habitats are common in all streams, but are most extensive in streams within the Current River Hills Subsection. Streams are clear and cool with several streams classified as coldwater, which sustain trout populations. There are 9 different Aquatic Ecological System Types (AES-Types) found within the Black/Current EDU, which is the highest number of any EDU in the state (Figure 7). These AES-Types differ in terms of all landscape features, but especially in terms of groundwater contributons and springs. Some of the principle management concerns include; nonpoint source pollution (erosion/sedimentation and organic wastes), overgrazing, gravel and lead mining, removal and fragmentation of riparian vegetation, altered thermal regimes, roads and bridges, and intense recreational use.

A total of 133 fish, 46 mussels, and 14 crayfish either inhabit or at one time inhabited the Black/Current EDU, which is the highest number of species in the state. According to the Missouri Natural Heritage Program there are 22 globally listed (rare, threatened, or endangered) species and 41 state listed species. The fish assemblage is characterized by regionally and locally endemic, intolerant, species and could generally be classified according to the dominant families as a Minnow/Sucker/Sunfish/Darter assemblage. Distinctive fish species include the Arkansas saddled darter, Current darter, brook darter, sabine shiner, Ozark madtom, Ozark chub, Ozark shiner, Ozark minnow, and Ozark sculpin. One of the most distinctive features of this EDU is the prevalence of lowland species in the lower sections of the Current and Black Rivers.

The golden and spothanded crayfish are the most widespread crayfish species. Six species of crayfish have a distribution in the watershed limited to the Little Black River Hydrologic Unit. These include the Cajun dwarf, digger, shield, gray-speckled, red swamp, and vernal crayfish. Other distinctive crayfish species include the coldwater, Mammoth Spring, Ozark, and woodland crayfish. Common and distinctive mussels include the Arkansas brokenray, Curtis pearlymussel, fatmucket, pondmussel, giant floater, little spectaclecase, and Ouachita kidneyshell.

Gasconade EDU

The Gasconade EDU lies southcentral Missouri and comprises the entire watershed of the Gasconade River, which is a tributary to the Missouri River (Figure 8). Overall there are 9,684 km of primary stream channel within this EDU, of which 2,532 km are classified as perennial in the 1:100,000 National Hydrography Dataset. This EDU is entirely contained within the Ozark Highlands Ecological Section as described by Bailey (1995). The landscape of Gasconade EDU can generally be broken into two distinct components, a) those lands that follow the topographic boundary of the Gasconade watershed and fall within the Central Plateau Subsection and b) those lands within the central part of the drainage and fall within the Gasconade River Hills Subsection.

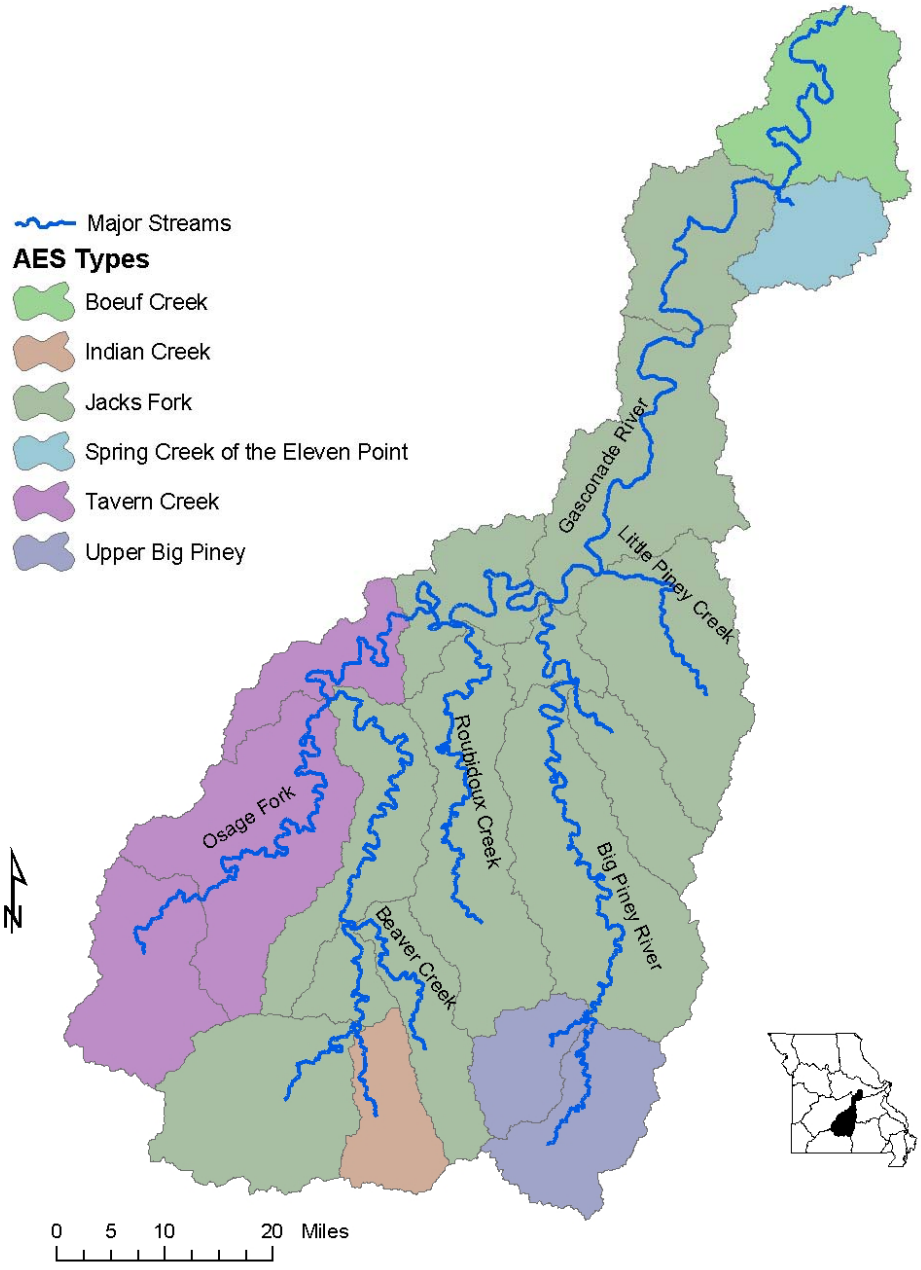


Figure 8. Map showing the boundaries and various Aquatic Ecological System Types for the Gasconade Ecological Drainage Unit.

The Central Plateau Subsection consists of some of the least dissected portions of the Ozark Highlands. It is dominated by a thick carobnate geology consisting mainly of cherty dolomites and some prominent sandstones, all of Ordovician age. Soil textures consist of cherty or silt loam soils with moderate to slow infiltration rates. Fragipans are widespread in the subsoil. Relief in this portion of the EDU is generally 50-150 feet. Floodplains tend to be narrow and not extensive, with very gravelly soils. This area is minimally dissected and most of the streams are either ephemeral or intermittent. Stream gradients are lower than those found in the Gasconade River Hills and substrates tend to be smaller, dominated by silts and gravels. Only small springs are common in this low relief landscape. This area was historically covered in a diverse mosaic of prairie, savanna, and open oak woodlands. Today it is largely covered in pasture and second growth timber.

The Gasconade River Hills is a deeply dissected landscape with steep slopes, narrow ridges, and narrow valley bottoms. Most of this subsection is underlain by thick, cherty dolomites, and sanstones of the Gasconade and Roubidoux formations of the early Ordovician. Weathering of the highly soluable dolomites has produced the karst landscape that dominates this subsection, including numerous large springs, losing streams, sinkholes and cave. Soils are formed in weathered bedrock and rock fragments are numerous. Surface soil textures consist of cherty soils and silt loams with moderate to slow infiltration rates. Soils formed from the Roubidoux formation are low in soluable bases such as calcium and magnesium, while those formed from the Gasconade formation have higher concentrations of these minerals. Relief is moderately high, ranging from 200-400 feet and stream gradients are much higher than the streams draining the Central Plateau. Substrates are a mixture of sand, gravel and cobble. Extensive sand and gravel bars are quite common within the active stream channel. Riffles and bluff pool habitats are common. Historically, a mosaic of oak savanna, woodland, and forest covered this subsection. Shortleaf pine-oak woodlands and forests were also common along the Big and Little Piney Rivers. Glades were also scattered throughout. Today the area is mainly covered in oak and oak-pine woodlands and forest with a few shortleaf pine plantations. Much of the bottomland has been cleared but fragments of well-developed bottomland forest still remain.

The average gradient across all stream size classes is 13.4 m/km. Average gradients (m/km) by size class are: headwater 18.5, creek, 4.6, small river 1.2, and large river 0.5. Streams are largely surface-water dominated within the Central Plateau Subsection with scatterd small spring inputs, while streams in the Gasconade River Hills Subsection are largely dominated by springflow. Riffle habitats are common in all streams, but are most extensive in streams within the Gasconade River Hills Subsection. Streams are clear and cool with several streams classified as coldwater, which sustain trout populations. There are six different Aquatic Ecological System Types (AES-Types) within the Gasconade EDU, which differ mainly in terms of geology, relief, gradient, and spring flow (Figure 8). Some of the principle management concerns include; nonpoint source pollution (erosion/sedimentation and organic wastes), overgrazing, gravel mining, removal and fragmentation of riparian vegetation, and altered thermal regimes.

A total of 106 fish, 45 mussels, and 6 crayfish either inhabit or at one time inhabited the Gasconade EDU. According to the Missouri Natural Heritage Program there are 10 globally listed (rare, threatened, or endangered) species and 24 state listed species. The fish assemblage is characterized by regionally endemic, intolerant, species and could generally be classified according to the dominant families as a Minnow/Sucker/Sunfish/Darter

assemblage. The most widely distributed species of Cyprinids are the bleeding shiner, hornyhead chub, and largescale and central stonerollers. Among the Centrarchids, the longear sunfish, rock bass, bluegill, sunfish, smallmouth bass, largemouth bass, and the spotted bass are some of the most widely distributed species. The bluestripe and least darters are distinctive Percids. Also, the Gasconade River is one of the few remaining unimpounded rivers from the source to the mouth, which allows the free movement of fish such as the American eel and the Alabama shad. Common and distinctive crayfish species include the golden, Salem cave, and spothanded. Distinctive mussels include the Ozark pigtoe and northern brokenray.

Meramec EDU

The Meramec EDU lies in eastcentral Missouri and empties into the Mississippi River just south of the city of St. Louis (Figure 9). It drains a total area of 3,963 square miles, all of which lies within the Ozark Highlands Ecological Section. In addition to the Meramec River, for which this EDU is named, major streams draining this EDU include; the Big, Bourbeuse, Courtois, Crooked, Dry, Dry Fork, Huzzah, Indian and Little Meramec. There are 10,581 kilometers of primary channel stream within this EDU, of which 2,978 Km are classified as perennial in the National Hydrography Dataset.

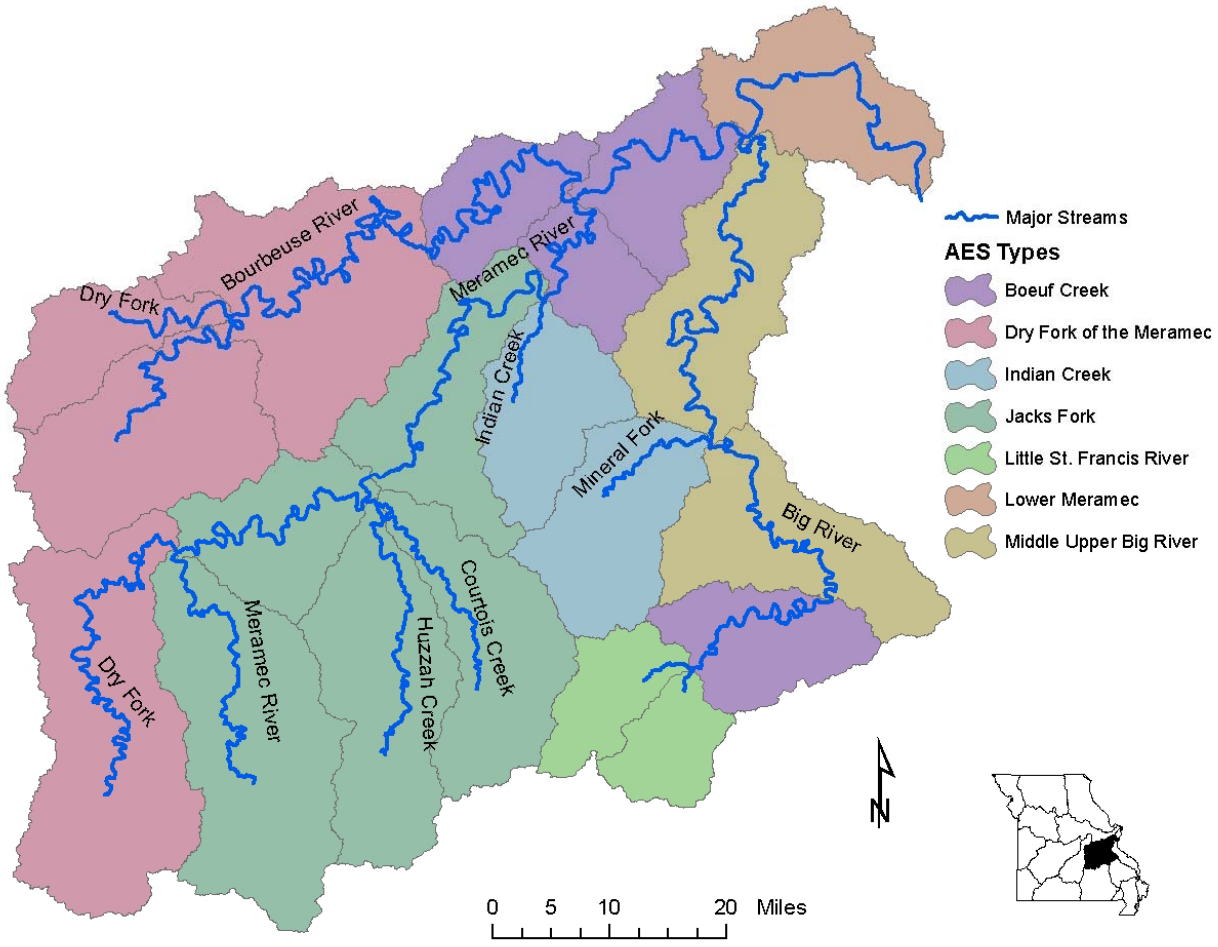


Figure 9. Map showing the boundaries and various Aquatic Ecological System Types for the Meramec Ecological Drainage Unit.

The Meramec EDU is physiographically diverse and for discussion purposes, it is easiest to describe the physiographic character according to the three Ecological Subsections (Nigh and Schroeder 2002) that cover the majority of this EDU, the Central Plateau, Meramec River Hills, and the St. Francois Knobs and Basins.

The Dry Fork and Bourbeuse River watersheds respectively drain the southwestern and northwestern portions of this EDU. These two watersheds fall within the Central Plateau Ecological Subsection. The Central Plateau Subsection consists of some of the least

dissected portions of the Ozark Highlands. It is dominated by a thick carobnate geology consisting mainly of cherty dolomites and some prominent sandstones, all of Ordovician age. Soil textures consist of cherty or silt loam soils with moderate to slow infiltration rates. Fragipans are widespread in the subsoil. Relief in this portion of the EDU is generally 50-150 feet. Floodplains tend to be narrow and not extensive, with very gravelly soils. This area is minimally dissected and most of the streams are either ephemeral or intermittent. Stream gradients are lower, substrates smaller, and waters are warmer and more turbid than those found in the rest of the EDU. Only a few small springs are found in this low relief landscape. This area was historically covered in a diverse mosaic of prairie, savanna, and open oak woodlands. Today it is largely covered in pasture and second growth timber. Some of the principle management concerns include overgrazing, fragmentation of riparian forest cover, headwater impoundments, gravel mining, and abandoned lead and coal mines.

The Meramec River Hills Subsection is more deeply and intricately dissected than the previously discussed subsection and possess higher relief (100-300 feet) and higher gradient streams (Pflieger 1985). The Ordovician Roubidoux and Gasconade Formations and the older Cambrian Eminence and Potosi Formations underlie most of this portion of the EDU (Nigh and Schroeder 2002). Karst features such as caves, sinkholes, and underground streams are locally prominent. Soils are very cherty silty loams with moderate infiltration rates. Small and large springs are numerous and the streams are generally cool and clear. The karst causes the flow in headwaters and creeks to be quite varied, with those that are fed by springs having relatively high sustained baseflows while those that a) are dominated by surface runoff or b) lose a portion of their flow to neighboring drainages will be dry or intermittent at baseflow. Small and Large Rivers generally have high sustained baseflows due to the presence of several large springs along these mainstem rivers. Streams carry large bedloads of coarse substrates and their channels generally contain immense deposits of gravel and cobble substrates that form extensive gravel bars along the channel margins. Riffles and pools are well developed, with bluff pool habitats nearly as abundant as those found in the Current and Jack's Fork Rivers. Historically this area was covered in oak and oak-pine forests and woodlands, while the bottomlands were mainly well forested with a mix of hardwood and riverfront sycamore-cottonwood types. Today this region is still mainly timbered, except for the cleared bottomlands and flatter ridges. The forests are denser today as a result of fire suppression and shortleaf pine is much less abundant. Management concerns include urbanization, fragmentation of riparian forest cover, gravel mining, intense recreation, alteration of thermal regimes, and runoff from abandoned lead mines.

The upper portions of the Big River drain the St. Francois Knobs and Basins. The presence of exposed Precambrian bedrock and tremendously high relief make this portion of the EDU distinct, even within the context of the Ozark Highlands. This subsection lies at the structural center of the Ozark dome and is underlain by billion-year-old Precambrian igneous rocks. The topography consists of irregularly spaced igneous knobs surrounded by gently rolling basins floored by sedimentary rocks, of mainly dolomite and sandstone. Relief is highest surrounding the igneous knobs (300-1000 feet), but much lower in the surrounding cherty hills (200-300 feet) and dolomite plains (100-200 feet). Stream gradients follow this same pattern. This subsection also contains many valuable mineral deposits that have been mined for over 200 years, including lead, iron, maganese, silver, cobalt, and granite. Soils are quite varied and relate to the bedrock lithology and landscape position within the subsection. Within the igneous bedrock regions the soils are moderately deep

and acidic, with low amounts of soluable bases. Streams with watersheds having a high percentage of igeneous bedrock tend to have a relatively low pH, low conductivities, and low suspended sediment concentrations even during elevated flows. Another distinctive feature are the many high gradient “shut-ins” that form where streams cut through areas containing these highly resistant igneous rocks. Streams are clear and water quality is relatively good in this region except for streams draining mining lands or areas with a high percentage of grazing lands. Springs are common, but mostly small in volume and mainly occur at the geologic boundary of the Elivins Group and the highly karst Eminence/Potosi formations. Flash floods are common and many of the small channels have poorly sustained base flows due to the low abundance of groundwater within the igneous regions. Historically this region was covered in a distinct mix of forest, woodland, glade and cliff communities on igneous substrates. Most of the rougher lands are still forested in second growth oak and oak-pine forests, however, the forests are denser and shortleaf pine has decreased in abundance. Igneous glade communities, which were historically maintained by fire, have slowly diminshed in area over time as a result of fire suppression. Management concerns include upland grazing, fragmentation of riparian forest cover, gravel mining, intense recreation, alteration of thermal regimes, and runoff from abandoned lead mines.

The average gradient across all stream size classes is 13.1 m/Km. Average gradients (m/Km) by size class are: headwater 17.6, creek, 4.0, small river 1.1, and large river 0.5. Seven distinct Aquatic Ecological System (AES) Types are found within the Ozark/Meramec EDU (Figure 9). These AES-Types differ in terms of all major landscape and hydrologic features (i.e., geology, soils, landform, and groundwater influence).

There are 123 fish, 46 mussel and 8 crayfish species that either inhabit, or at one time inhabited, the Meramec EDU. According to the Missouri Natural Heritage database there are 15 globally listed (rare, threatened, or endangered) species and 37 state listed species. There are no fish species restricted to the Meramec EDU. The distinctiveness of the fish assemblage is in the unique combination of species that occur in neighboring drainages to the west and south. Distinctive fish species include silverjaw minnow, striped shiner, steelcolor shiner, rainbow darter, river darter, and logperch. Common and distinctive mussel species include the giant floater, fatmucket, northern brokenray, Ouachita kidneyshell, and the pondmussel. Common and distinctive crayfish species include the belted, devil, freckled, spothanded, saddlebacked, and woodland crayfish.

Moreau/Loutre EDU

The Moreau/Loutre EDU lies in eastcentral Missouri (Figure 10). It includes all of the smaller direct tributaries to the Missouri river downstream of the outlet of the Little Chariton River, extending to the confluence of the Missouri and Mississippi Rivers. The EDU is primarily within the Ozark Highlands, however, the northern and western boundaries also extend into the Central Dissected Till Plains as described by Bailey (1995). Overall there are 13,050 km of primary stream channel within this EDU, of which 3,762 km are classified as perennial in the 1:100,000 National Hydrography Dataset. Because this EDU straddles two major ecoregions and also contains the lower Missouri River, it is very physiographically, hydrologically, and biologically diverse. The EDU is mainly within the Inner and Outer Ozark Border ecological subsections, but also includes portions of the Prairie Ozark Border and the Claypan Till Plains subsections.

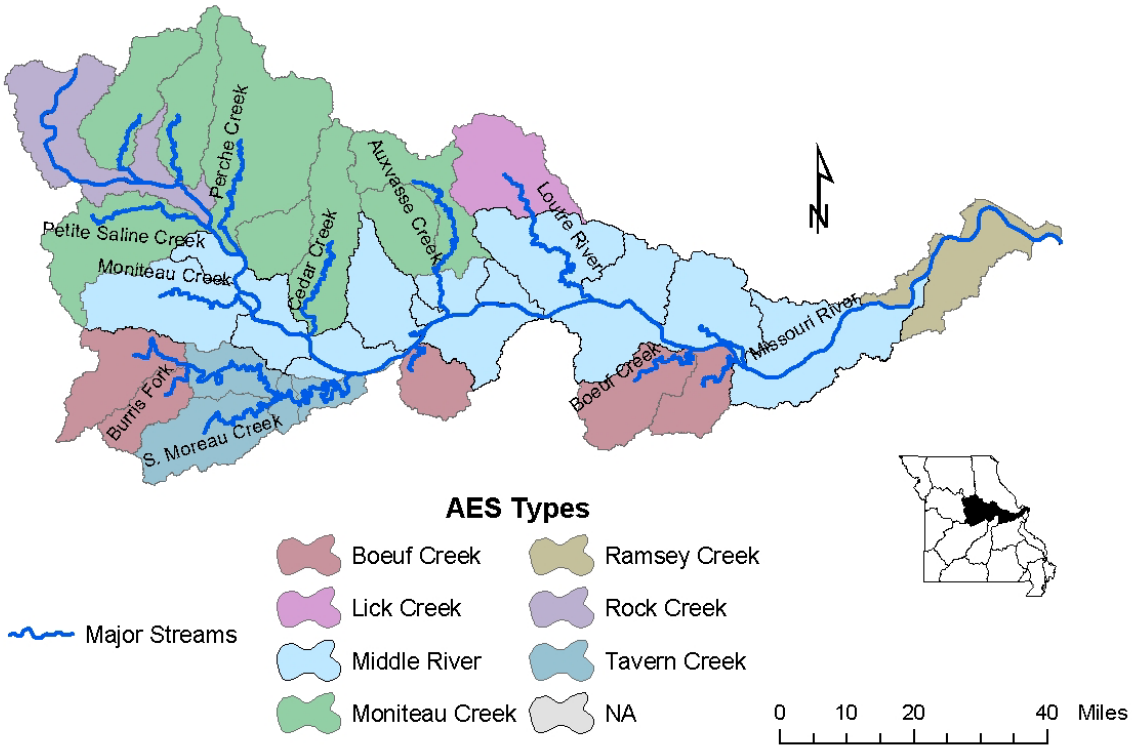


Figure 10. Map showing the boundaries and various Aquatic Ecological System Types for the Moreau/Loutre Ecological Drainage Unit.

Essentially there is an east to west and north to south gradient in environmental conditions within this EDU. The landscape in the north and west is more prairie in nature with lower relief (150-300 feet), deeper and more fine textured soils, underlain by MS limestones, and fewer springs. The streams draining these landscapes are warmer and more turbid with a higher percentage of sand and silt substrates. Streams in the south and east are more Ozark in character; clear and cool with coarse substrates, higher gradients, and more well developed riffle-pool morphology. These conditions correspond with changes in physiography; higher relief, Ordovician dolomites, shallow cherty soils, and higher spring densities.

The average gradient across all stream size classes is 10.1 m/km. Average gradients (m/km) by size class are: headwater 13.3, creek, 2.6, small river 0.6, and large river 0.4. Streams are largely surface-water dominated with scattered small spring inputs. Riffle habitats are common in all streams, but increase in occurrence as you move toward the south and east. There are 8 different Aquatic Ecological System Types (AES-Types) found within the Moreau/Loutre EDU, which is the second highest in the state (Figure 10). These AES-Types differ in terms of all landscape features, but especially in terms of geology and soils. Some of the principle management concerns include; nonpoint source pollution (erosion/sedimentation and organic wastes), overgrazing, coal, gravel, and lead mining, removal and fragmentation of riparian vegetation, altered thermal regimes, roads and bridges, and industrial and municpal effluents.

A total of 113 fish, 26 mussels, and 6 crayfish either inhabit or at one time inhabited the Moreau/Loutre EDU. According to the Missouri Natural Heritage Program there are 8 globally listed (rare, threatened, or endangered) species and 20 state listed species. The fish assemblage is characterized by a distinct mixture of Prairie, Ozark, and Great River species and could be classified according to the dominant families as a Minnow/Sucker/Darter assemblage. Distinctive fish species include the Missouri saddled darter, stippled darter, blackside darter, Ozark minnow, flathead chub, bleeding shiner, blacknose shiner, and the Topeka shiner. One of the most distinctive features of this EDU is the prevalence of Great River species in the lower sections of the major tributaries.

The most common mussel species are the giant floater, pondmussel, and fatmucket. The virile, spothanded, papershell, and devil are the most common crayfish species.

Neosho EDU

The Neosho EDU straddles portions of four states, southwestern Missouri, southeastern Kansas, northeastern Oklahoma, and northwestern Arkansas (Figure 11). Overall there are 10,309 Km of primary stream channel within this EDU, of which 2,412 Km are classified as perennial in the National Hydrography Dataset. Of this total 6,772 Km (66%) falls within Missouri.

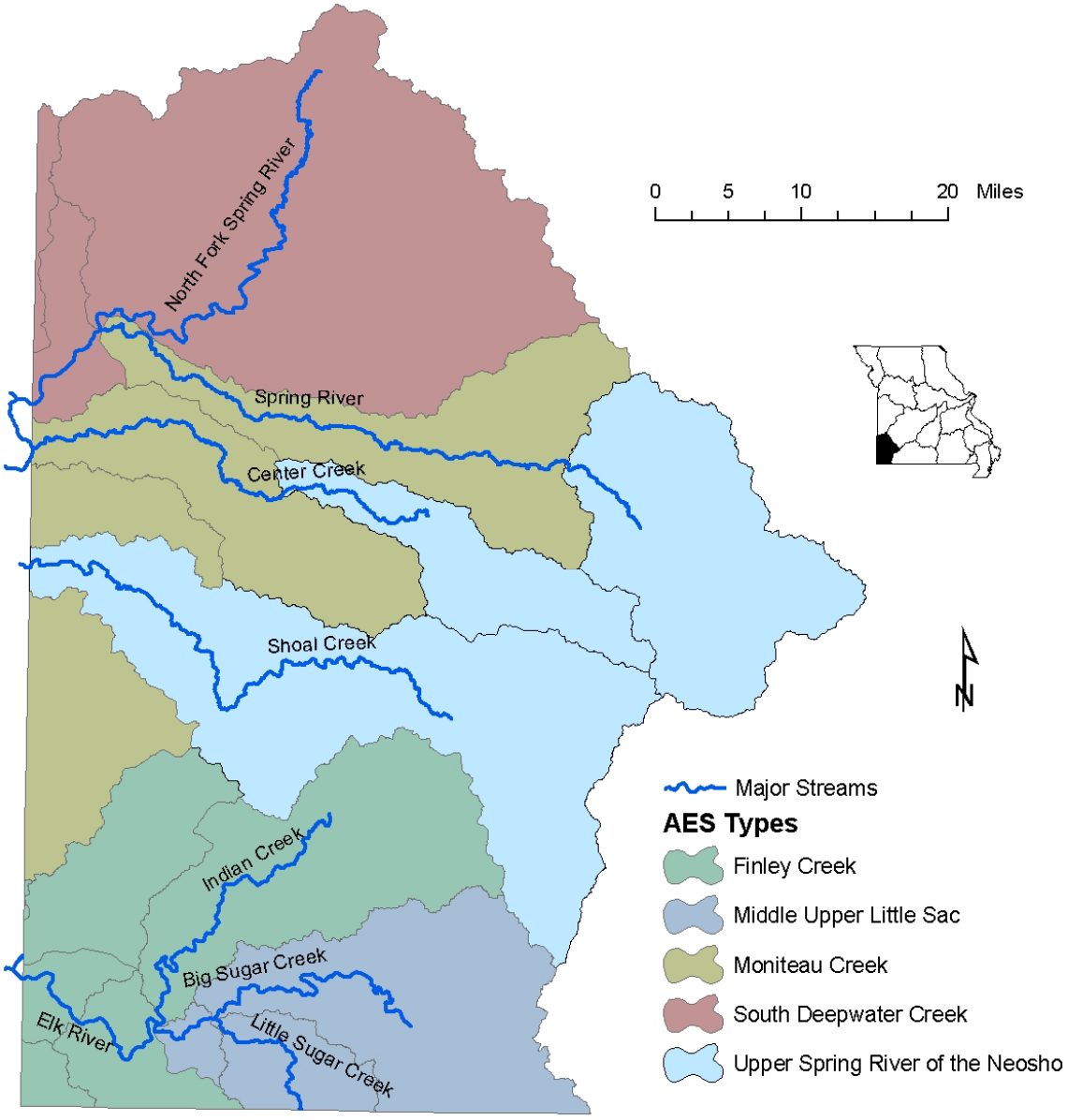


Figure 11. Map showing the boundaries and various Aquatic Ecological System Types for the Neosho Ecological Drainage Unit.

This EDU is largely contained within the Ozark Plateau, however, the northernmost edge, which includes much of the North Fork of the Spring River and its northern tributaries, falls within the Osage Plains. Specifically, this EDU covers four ecological subsections, the Cherokee Plain, Springfield Plain, Springfield Plateau, and Elk River Hills.

The Cherokee Plain is mainly underlain by Pennsylvanian deposits that are overlain by upto 6 feet of loess. The lithology consists of alternating beds of limestone, sandstone, shale and coal. The sandstone and shale impeed downward water movement, making for poor aquifers, which results in these streams being largely surface water dominated. As a result, most of the smaller streams are ephemeral or intermittent. Even the largest streams have extremely low discharges during extended dry periods. Topography is gently rolling, with relief generally in the range of 100-150 feet within the northwest trending limestone escarpments, and 50 feet in the interceeding regions, which are dominated by shale. Streams occupy broad, shallow valleys that slope gradually into the flat to gently rolling uplands. Stream channels are highly meandering, entrenched, with extremely low gradients (although channels running off the escarpments have relatively high gradients). Waters are generally turbid and substrates mainly sand and silt, with riffles poorly defined or often completely absent, but when present contain slate-like pieces of shale and sandstone embedded in fines. Bedrock is intermittently exposed in some of smaller streams.

The Springfield Plain is mainly underlain by very cherty Mississippian limestones, with some smaller inclusions of more resistant Pennsylvanian sandstone and shale deposits, which tend to form ridges that rise above a generally flat plain. The high percentage of limestone results in high groundwater contributions to streams within this AES-Type, and springs and other karst features (sinkhole ponds/caves) are quite abundant. Local relief is generally 100 to 200 feet. The moderately deep soils formed from the weathering of the underlying cherty limestones, are loams/silt-loams of medium to fine textured, have slow to moderate infiltration rates and often are covered with thin layer of loess. Streams have an Ozark-Border character, with moderate gradients and spring influence. Waters are fairly clear and substrates mainly chert gravel and cobble, with well-defined riffles, although some streams still have relatively high percentages of fine materials, mainly sand. Gravel bars are quite prevalent.

The Springfield Plateau and Elk River Hills are mainly underlain by very cherty Mississippian limestones, but the deepest valleys cut through the Devonian limestones into the Ordovician Jefferson City-Cotter formations. The high percentage of limestone results in high groundwater contributions to streams within these subsections and springs and caves are quite abundant. Local relief is generally quite high 150 to 250 feet, but drops to just 100 feet in the extreme southwest, and upto 350 feet in other places. Cliffs and streamside bluffs are common. There is a mixture of deep red clayey soils on the backslopes interspersed with very shallow soils surrounding the many limestone glades that dot the area. Streams are very Ozark in character, they occupy narrow valleys separated by steep narrow ridges with clear water, high base flows, and low suspended sediment loads. Substrates mainly chert gravel and cobble, with well-defined riffles, gravel bars and bluff pools are quite prevalent. Extensive stretches of bedrock channels also exist. The steep slopes combined with the moderate to slow infiltration rates of the soils results in the streams having a flashy hydrograph with flooding common during and after intense rainfall events, which bypass the karst drainage system

The average gradient across all stream size classes is 7.4 m/Km. Average gradients (m/Km) by size class are: headwater 9.7, creek, 3.0, small river 1.0, and large river 0.5. Springs are quite common, but small, except in the North Fork of the Spring River where they are virtually absent. Several small coldwater streams exist within this EDU, mainly tributaries within the upper Spring River, Center Creek, and Shoal Creek watersheds. Within Missouri there are five distinct Aquatic Ecological System Types (AES-Types) within the Neosho EDU (Figure 11). The South Deepwater Creek AES-Type covers the northern edge of the EDU and contains prairie streams draining the Osage Plains. The other four AES-Types fall within the Ozarks and, moving from north to south, are; Moniteau Creek, Upper Spring River, Finley Creek, and Middle Upper Little Sac.

The Neosho EDU has one of the most distinctive aquatic faunas in the state due to the unique coccurrence of species that are characteristic of the Ozarks and also the Central Plains. A total of 89 fish, 44 mussels, and only 4 crayfish either inhabit or at one time inhabited this EDU. According to the Missouri Natural Heritage database there are 13 globally listed (rare, threatened, or endangered) species and 25 state listed species. The fish community can be generally classified as a Minnow/darter/catfish community for streams in the North Fork of the Spring River and a Minnow/Sunfish/Sucker community in the remainder of the EDU. Distinctive fish species include the redspot chub, bluntface shiner, cardinal shiner, southwest mimic shiner, western slim minnow, Neosho madtom, Arkansas darter, redfin shiner, channel darter, and the Ozark cavefish. Common or distinctive crayfish species include the bristly cave, Neosho midget, and ringed crayfish. Common or distinctive mussels include the western fanshell, Neosho mucket, and purple lilliput.

Osage EDU

The Osage EDU lies in southcentral Missouri and encompasses the lower portion of the Osage River watershed, which falls within the Ozark Highlands as defined by Bailey (1995)(Figure 12). Overall there are 16,553 km of primary stream channel within this EDU, of which 4,794 km are classified as perennial in the 1:100,000 National Hydrography Dataset. The Osage River, for which this EDU is named, is the third largest river in Missouri and is a tributary to the Missouri River. Other major streams within this EDU include the Sac, Pomme de Terre, and Niangua Rivers.

Figure 12. Map showing the boundaries and various Aquatic Ecological System Types for the Osage Ecological Drainage Unit.

The landscape of this EDU is nearly equally divided among three ecological subsections; the Central Plateau, Osage River Hills, and Springfield Plain. The average gradient across all stream size classes is 11.9 m/km. Average gradients (m/km) by size class are: headwater 15.7, creek, 3.6, small river 1.0, and large river 0.3. For sake of brevity and ease of comparative undertanding, it is best to describe the geographic variation in landscape and stream conditions in terms of these broader ecoregions. However, it should be noted that a total of eight different Aquatic Ecological System Types were delineated within the Osage EDU in order to account for the more detailed, but equally important, differences in watershed and stream conditions that exist within this EDU (Figure 12).

The southern and eastern portions of the Osage EDU fall within the Central Plateau Ecological Subsection. The Central Plateau Subsection consists of some of the least dissected portions of the Ozark Highlands. It is dominated by a thick carobnate geology consisting mainly of cherty dolomites and some prominent sandstones, all of Ordovician age. Soil surface textures are mainly cherty loams or silt loams with moderate to slow infiltration rates. Fragipans are widespread in the subsoil. Relief in this portion of the EDU is generally 50-150 feet. Floodplains tend to be narrow and not extensive, with very gravelly soils. This area is minimally dissected and many of the streams are either ephemeral or intermittent. Stream gradients are lower, substrates smaller, and waters are warmer and more turbid than those found in the Osage River Hill subsection. Only a few small springs are found in this low relief landscape. This area was historically covered in a diverse mosaic of prairie, savanna, and open oak woodlands. Today it is largely covered in pasture and second growth timber. Some of the principle management concerns include fragmentation and inundation by Lake of the Ozarks and Pomme de Terre reservoir, overgrazing, fragmentation of riparian forest cover, gravel mines, and runoff from CAFOs and abandoned lead mines.

The northern portion of the EDU falls within the Osage River Hills Ecological Subsection. This subsection is composed of hilly to rugged lands bordering the Osage River and the lower mainstems of the principle tributaries. Cherty dolomites and sandstones of the Gasconade and Roubidoux formations underlie the area. Karst features are very prevalent in those areas underlain by dolomite. Springs, some quite large, are abundant here resulting in coldwater fisheries in some streams like the Niangua River. Relief is quite high (200-350 feet), with some areas over 350 feet. Soils are moderately thick and mainly coarse to very coarse loams and silty loams with moderate infiltration rates. Smaller streams have relatively high gradients and carry large bedloads of cobble, gravel, and sand, which result in extensive gravel and sand bars. Riffles are well developed and waters are generally very clear and often cool. Historically this region was covered in a mosaic of tallgrass prairie, glades, oak savanna, oak woodlands, and oak forests. Most of the prairie and open woodlands have been converted to pasture, however, a high percentage of the glade, woodland, and forest remains within the steepest lands. Some of the principle management concerns include fragmentation and inundation by Lake of the Ozarks and Truman Reservoir, intense recreational use, gravel mining, and runoff from abandoned lead mines.

The southwestern portion of the EDU falls within the Springfield Plain. This ecological subsection is mainly underlain by very cherty Mississippian limestones, with some smaller inclusions of more resistant Pennsylvanian sandstone and shale deposits, which tend to form ridges that rise above a generally flat plain. The high percentage of limestone results

in high groundwater contributions to streams within this AES-Type, and springs and other karst features (sinkhole ponds/caves) are quite abundant. Local relief is generally 100 to 200 feet. The moderately deep soils formed from the weathering of the underlying cherty limestones, are loams/silt-loams of medium to fine textured, have slow to moderate infiltration rates and often are covered with thin layer of loess. Streams have an Ozark-Border character, with moderate gradients and spring influence. Waters are fairly clear and substrates mainly chert gravel and cobble, with well-defined riffles, although some streams still have relatively high percentages of fine materials, mainly sand. Gravel and sand bars are quite prevalent. Historically this are represented a transitioin zone between the prairies to the west and the forests to the east. Prairies graded into extensive oak savannas and into oak woodlands and oak forests in the most dissected areas. Glades, sinkhole ponds, and depressional wetlands were scattered throughout this area. Today this subsection is dominated by fescue pasture and small isolated woodlots of invasive trees and shrubs. Some of the principle management concerns include fragmentation and inundation by Stockton Lake and Truman Reservoir, overgrazing, fragmentation of riparian forest cover, urbanization, and runoff from CAFOs and abandoned lead mines.

There are 116 fish, 46 mussel and 6 crayfish species that either inhabit, or at one time inhabited, the Osage EDU. According to the Missouri Natural Heritage database there are 17 globally listed (rare, threatened, or endangered) species and 32 state listed species. The Osage EDU contains a unique combination of species that are characteristic of of neighboring EDUs in the Ozarks and Central Plains. Distinctive fish species include the bluestripe darter, Niangua darter, and Ozark cavefish. Common or dinstinctive mussel species include the giant floater, fatmucket, northern brokenray, Ouachita kidneyshell, Ozark pigtoe, pondmussel, and western fanshell. Common or distinctive crayfish include the bristly cave, devil, golden, and virile crayfish.

Upper St. Francis/Castor EDU

The Upper St. Francis/Castor EDU lies in southeastern Missouri. It covers those portions the St. Francis, Castor, and Whitewater River watersheds and the Headwater Diversion Channel that fall within the Ozark Highlands as described by Bailey (1995) (Figure 13). It also includes the Ramsey Creek watershed, which drains the Benton Hills northward into the Headwater Diversion Channel. Historically, the Castor and Whitewater Rivers were tributaries to the St. Francis River and continued their southward course into the Mississippi Alluvial Basin (i.e., Bootheel). However, in order to reduce the amount of runoff into the poorly drained lowlands the Headwater Diversion Channel was constructed in the early 1900's and now these two rivers drain into the Mississippi river via the diversion channel. Presently, there are 6,430 km of primary stream channel within this EDU, of which 2,290 km are classified as perennial in the 1:100,000 National Hydrography Dataset.

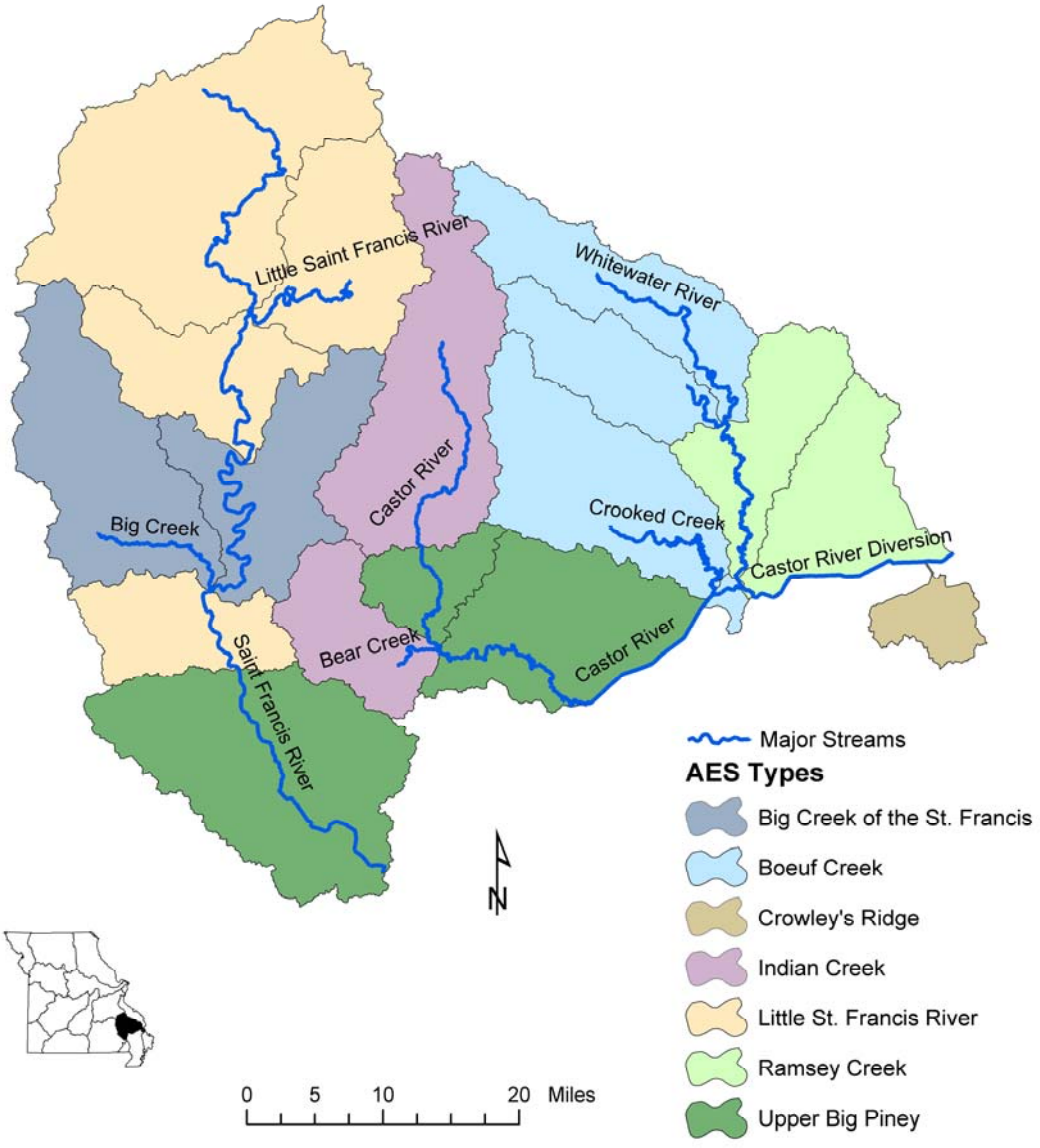


Figure 13. Map showing the boundaries and various Aquatic Ecological System Types for the Upper St. Francis/Castor Ecological Drainage Unit.

About half of the EDU falls within the St. Francois Knobs and Basins ecological subsection, while the other half, to the south and east, straddles three other subsections; the Black River Ozark Border, Inner Ozark Border, and Outer Ozark Border. The seven distinct Aquatic Ecological System (AES)-Types within this EDU, which differ in terms of all four major landscape features used to delineate the AES-Types (i.e., geology, soils, landform, and groundwater influences), reflect these distinct physiographic settings (Figure 13). The presence of exposed Precambrian bedrock and tremendously high relief make the St. Francois Knobs and Basins portion of the EDU distinct, even within the context of the Ozark Highlands. This subsection lies at the structural center of the Ozark dome and is underlain by billion-year-old Precambrian igneous rocks. These igneous rocks consist of batholithic granites with intrusions of rhyolite and other volcanic rocks. The topography consists of irregularly spaced igneous knobs surrounded by gently rolling basins floored by sedimentary rocks, of mainly dolomite and sandstone. Relief is highest surrounding the igneous knobs (300-1000 feet), but much lower in the surrounding cherty hills (200-300 feet) and dolomite plains (100-200 feet). Stream gradients follow this same pattern. This subsection also contains many valuable mineral deposits that have been mined for over 200 years, including lead, iron, maganese, silver, cobalt, and granite. Soils are quite varied and relate to the bedrock lithology and landscape position within the subsection. Within the igneous bedrock regions the soils are moderately deep and acidic, with low amounts of soluable bases. Streams with watersheds having a high percentage of igeneous bedrock tend to have a relatively low pH, low conductivities, and low suspended sediment concentrations even during elevated flows. Another distinctive feature is the many high gradient “shut-ins” that form where streams cut through areas containing these highly resistant igneous rocks. Streams are clear and water quality is relatively good in this region except for streams draining mining lands or areas with a high percentage of grazing lands. Springs are common, but mostly small in volume and mainly occur at the boundary of the Elivins Group and the highly karst Eminence/Potosi formations. Flash floods are common and many of the small channels have poorly sustained base flows due to the low abundance of groundwater within the igneous regions. Many common Ozark species are not found in streams draining this portion of the EDU.

Before exiting the state the St. Francis River cuts through a transition zone known as the Black River Ozark Border. This landscape is largely dominated by Roubidoux sandstone with Gasconade dolomite underlying the more deeply dissected valleys along the major streams. Relief ranges from relatively flat in the flatwoods regions where stream dissection is minimal to 300 feet. Soils are mostly deep to very deep, yet intense intense runoff and rapidly rising hydrographs are still the norm. Springs are not common here due to the prevalence of the Roubidoux sandstone. Stream gradients are lower than in the St. Francis Knobs and Basins subsection but higher than those found in the Inner and Outer Ozark Border subsections of this EDU. Streams manily have gravel and cobble substrates, however, as streams approach the Ozark Escarpment their gradients decrease dramatically and the percentage of fine substrates increases, with silt often becoming dominant.

The Inner and Outer Ozark Border Ecological subsections differ mainly in terms of bedrock geology and relief. The Outer Ozark Border, as it runs along the MS River, generally has lower relief (150 feet) and is underlain by Mississippian limstones, which corresponds with the distributional limit of many Ozark aquatic species. The Inner Ozark Border has generally higher relief (150-300 feet) and is underlain by Ordovician dolomites. Within this

EDU, springs are not common in either of these landscapes and streams generally have relatively low gradients with cobble, gravel, and sand substrates.

The average gradient across all stream size classes is 12.6 m/km. Average gradients (m/km) by size class are: headwater 16.7, creek, 3.7, small river 1.2, and large river 0.4. Streams are largely surface-water dominated with scattered small spring inputs, except in Big Creek and Twelvemile Creek where springs are quite abundant. Riffle habitats are common in all streams. Streams are clear and cool or warm with good water quality and riparian conditions in most places. Some of the principle management concerns include; gravel and lead mining, channelization, inundation and fragementation from impoundments, roads and bridges, and intense recreational use.

A total of 130 fish, 45 mussels, and 14 crayfish either inhabit or at one time inhabited the Upper St. Francis/Castor EDU. According to the Missouri Natural Heritage Program there are 17 globally listed (rare, threatened, or endangered) species and 37 state listed species. The fish assemblage has no species that are unique to it. It is characterized by a distinctive combination of species found in adjacent EDUs and Aquatic Subregions. Distinctive/characteristic fish species include the shadow and spotted bass, longear sunfish, largescale stoneroller, striped shiner, steelcolor shiner, Ozark shiner, blackspotted topminnow, brindled madtom, rainbow darter, speckled darter, scaly sand darter, longnose darter, and dusky darter. Historically, one of the most distinctive features of this EDU was the prevalence of lowland species in the lower sections of the St. Francic River, however, the construction of Lake Wappapello innundated this transition zone and most of these lowland species no longer persist above the lake. The spothanded, devil, St. Francis River, virile, and golden crayfish are the most widespread crayfish species. The Big Creek and St. Francis River crayfish are edemic to this EDU. The Hubbs crayfish is also a distinctive species due to its occurrence only in south-flowing drainages of the Ozarks. Common mussels include the fatmucket, pondmussel, giant floater, little spectaclecase, and Ouachita kidneyshell.

White EDU

The White EDU lies in southern Missouri and northern Arkansas and encompasses that portion of the White River watershed within the Ozark Highlands as described by Bailey (1995)(Figure 14). Overall there are 20,880 Km of primary stream channel within this EDU, of which 5,283 Km are classified as perennial in the National Hydrography Dataset. Of this total 12,351 Km (59%) falls within Missouri. In addition to the White River, for which this EDU is named, the other major streams within this EDU include the James and North Fork of the White River.

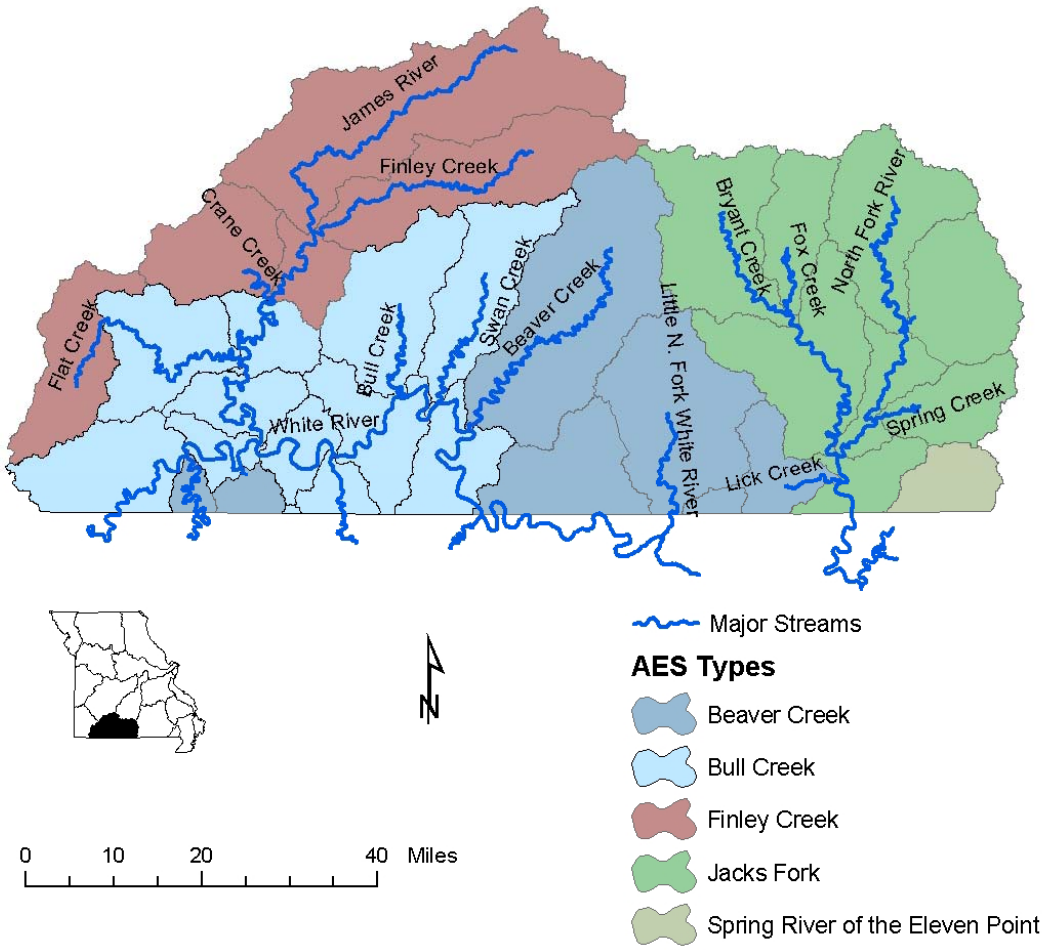


Figure 14. Map showing the boundaries and various Aquatic Ecological System Types for the White Ecological Drainage Unit.

The landscape of this EDU largely falls within the White River Hills Ecological Subsection. However, it also includes portions of the Central Plateau and Springfield Plain subsections. A distinctive feature of this EDU is the extremely high density of springs and the relatively high gradient of the streams across all size classes. The average gradient across all stream size classes is 18.2 m/km. Average gradients (m/km) by size class are: headwater 24.1, creek, 5.4, small river 1.5, and large river 0.6. For sake of brevity and ease of comparative undertanding it is best to describe the geographic variation in landscape and stream conditions according the major ecological subsections. However, it should be noted that a total of five different Aquatic Ecological System Types were delineated within the White

EDU in order to account for the more detailed, but equally important, differences in watershed and stream conditions that exist within this EDU.

The upper portions of the James River and Finley Creek watersheds fall within the Springfield Plain subsection. Some of the highest elevations in the state occur here, however, local relief is generally only 100-200 feet. This area is mainly underlain by very cherty MS limestones, but the deepest valleys cut through the Devonian limestones into the Ordovician Jefferson City-Cotter formations. The high percentage of limestone results in high groundwater contributions to streams within this area, and springs and cave are quite abundant. Some of the highest densities of sinkholes and losing streams can be found here. The relatively deep soils were formed in weathered cherty limestone and often capped thin mantle of loess as the surface material. Surface textures consist of cherty and silty loams with moderate to slow infiltration rates. Streams are generally Ozark in character and occupy narrow valleys separated by relatively broad ridges compared with other portions of the EDU. Streams are clear, with high base flows, and low suspended sediment loads, however these streams have a higher percentage of fine substrates than streams draining the White River Hill subsection and have higher suspended loads during periods of elevated discharge. Substrates mainly chert gravel and cobble, with well-defined riffles, gravel bars and bluff pools are quite prevalent. Extensive stretches of bedrock channels also exist. The steep slopes combined with the moderate to slow infiltration rates of the soils results in the streams having a flashy hydrograph with flooding common during and after intense rainfall events, which bypass the karst drainage system. Historically this portion of the EDU was covered in oak savanna and woodland. Cherty ridgetops generally supported isolated oak-pine woodlands. Glades and small prairie openings were also a common feature. Today the region is largely timbered with second-growth mixed-oak forests. The density of the woodlands has increased in the absence of fire. Most bottomlands and ridgetops have been cleared for pasture. Most glades are now severely overgrown with eastern red cedar. Some of the principle management concerns include lead and Zinc mine drainage, low pH and high SO4 concentrations, CAFO's, fragmentation of riparian forest, fragmentation from Table Rock Lake, road construction, urban development from Springfield, MO, and leaking septic tanks.

The White River Hills subsection is mainly underlain by the thick cherty, shaley dolomites of the Ordovician Jefferson City-Cotter formations. Local relief is generally quite high, ranging from 300 to 800 feet. The soils are very rocky/stony and consist of cherty and silty loams with slow to moderate infiltration rates. Streams very Ozark in character and occupy very narrow valleys separated by very narrow ridges compared with other portions of the EDU. Streams are clear, with high amazingly high gradients and base flows, and very low suspended sediment loads. Substrates mainly chert gravel, cobble, with well-defined riffles, gravel bars, sand bars and bluff pools are quite prevalent. Extensive stretches of boulder laiden and also bedrock channels exist. Springs are numerous, and streams have high groundwater contributions, but many of the smallest stream channels are ephemeral due to losses to the underlying karst drainage. The steep slopes combined with the moderate to slow infiltration rates of the soils results in the streams having a flashy hydrograph with flooding common during and after intense rainfall events. Historically this area contained one of the most distinct mosaics of terrestrial communities in the state. The region is particularly noted for its abundance of "bald knobs" (i.e., dolomite glades). These glades graded into open Oak/Savanna and woodland. Low slopes and bottoms were forested in oak and mixed deciduous hardwoods. Cane thickets were also common in the bottoms.

Cherty ridgetops generally supported isolated oak-pine woodlands. Small prairie openings were also a common feature. Today most of the dolomite glades and open woodlands have grown up in eastern red cedar and other invasive woody species. Glades are often overgrazed. The density and character of the woodlands have increased in the absence of fire. Most bottomlands have been cleared for pasture and Cane thickets are rare. Some of the principle management concerns include lead and zinc mine drainage, upland and riparian cattle grazing, excessive nutrient loads from nonpoint sources, fragmentation of riparian forest, fragmentation and innundation of critical habitats from Bull Shoals Reservoir and Table Rock Lake, road construction, gravel mining, urban development from Branson, MO, and leaking septic tanks.

There are 89 fish, 48 mussel and 9 crayfish species that either inhabit, or at one time inhabited, the White EDU. According to the Missouri Natural Heritage database there are 21 globally listed (rare, threatened, or endangered) species and 29 state listed species. The fish assemblage is characterized by regionally and locally endemic, intolerant, species and could generally be classified according to the dominant families as a Minnow/Sucker/Sunfish/Darter assemblage. Distinctive fish species include the duskystripe shiner, Ozark cavefish, and the yoke darter. Common and distinctive mussel species include the Arkansas brokenray, curtis pearlymussel, fatmucket, giant floater, Neosho mucket, and pondmussel. The crayfish assemblage is the most distinct in the state, with several locally endemic species including the bristly cave, longpincered, Meek's, Ozark, ringed, and William's crayfish. The most commonly encountered crayfish species include the Ozark, ringed, and spothanded.

Mississippi Alluvial Basin (MAB) Aquatic Subregion

Within Missouri the MAB Aquatic Subregion is partitioned into 3 Ecological Drainage Units; the Black/Cache, St. Francis/Little, and St. John's Bayou; all of which lie in the souteastern corner of Missouri. Differences among these EDUs are mainly biological in nature and relate to historic and present day isolation of these major drainage systems.

Black/Cache EDU

The Black/Cache EDU, a tributary to the White River, is relatively homogenous, with only a single AES-Type occurring within its boundary (at least within Missouri)(Figure 15). The distinct character of this EDU pertains to its connection with the two most diverse river systems of the Ozarks, the Black and Current Rivers. These rivers export large bedloads of coarse materials into streams otherwise dominated by fine substrates. This connection and dichotomy of structural features influences the biological composition of this EDU, which contains a relatively diverse aquatic assemblage containing 113 fish, mussel, and crayfish species, despite its small size.

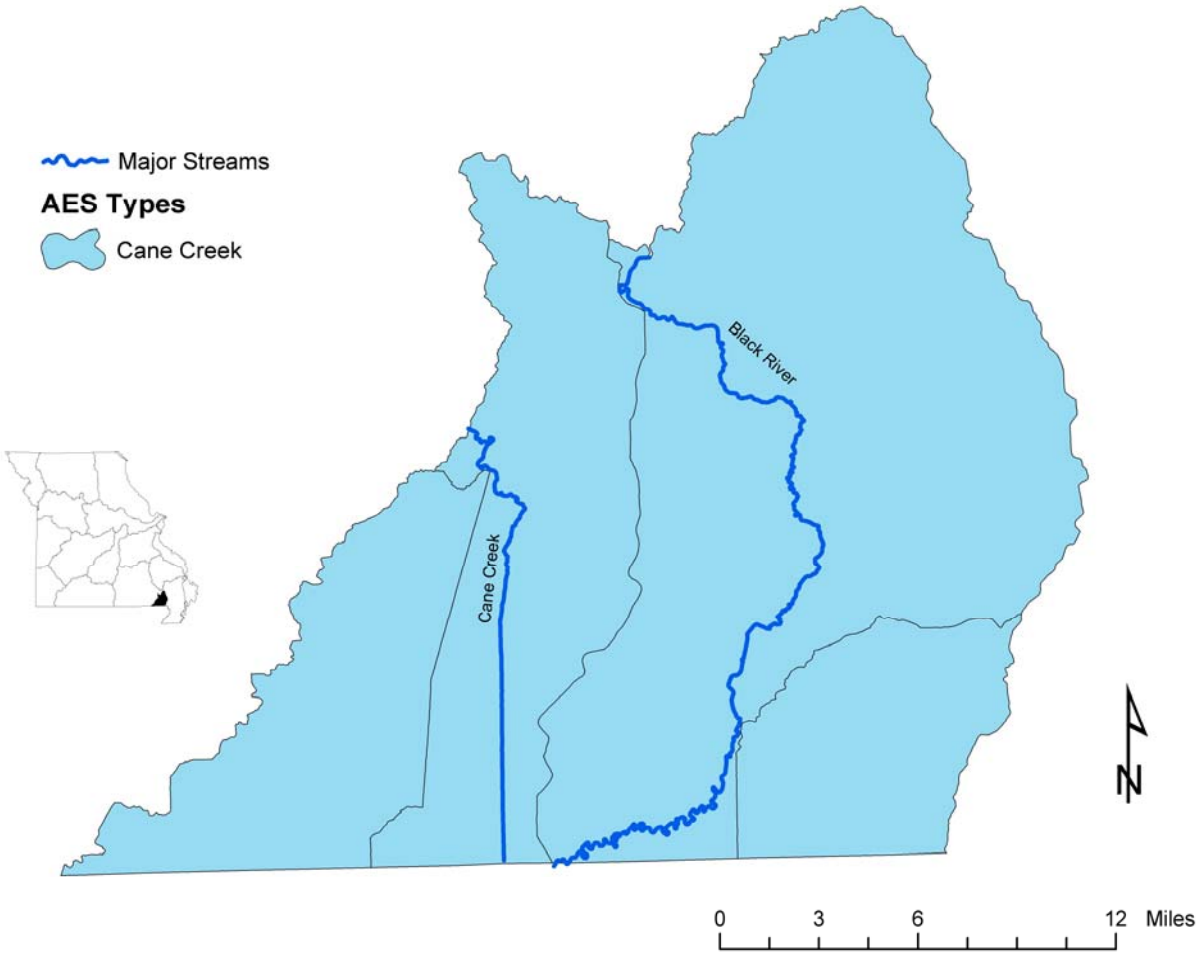


Figure 15. Map showing the boundaries and various Aquatic Ecological System Types for the Black/Cache Ecological Drainage Unit.

St. Francis/Little EDU

The St. Francis/Little EDU contains those portions of the St. Francis River and Little River watersheds within the MAB (Figure 16). The Little River is eventually a tributary to the St. Francis, which subsequently discharges into the Mississippi River near Helena, Arkansas. This EDU contains Crowley's ridge and Mingo National Wildlife Refuge. Historically, this area contained a diverse mosaic of plant communities and wetland types due to vagaries in elevation and soil conditions. These conditions are reflected in the 7 AES-Types that occur within this EDU (Figure 16). The boundaries of these AES-Types largely follow the Landtype Associations of Nigh and Schroeder (2002), however, the further restriction of drainage boundaries prohibits a perfect correspondence. A total of 130 fish, mussel and crayfish either inhabit or one time inhabited the St. Francis/Little EDU.

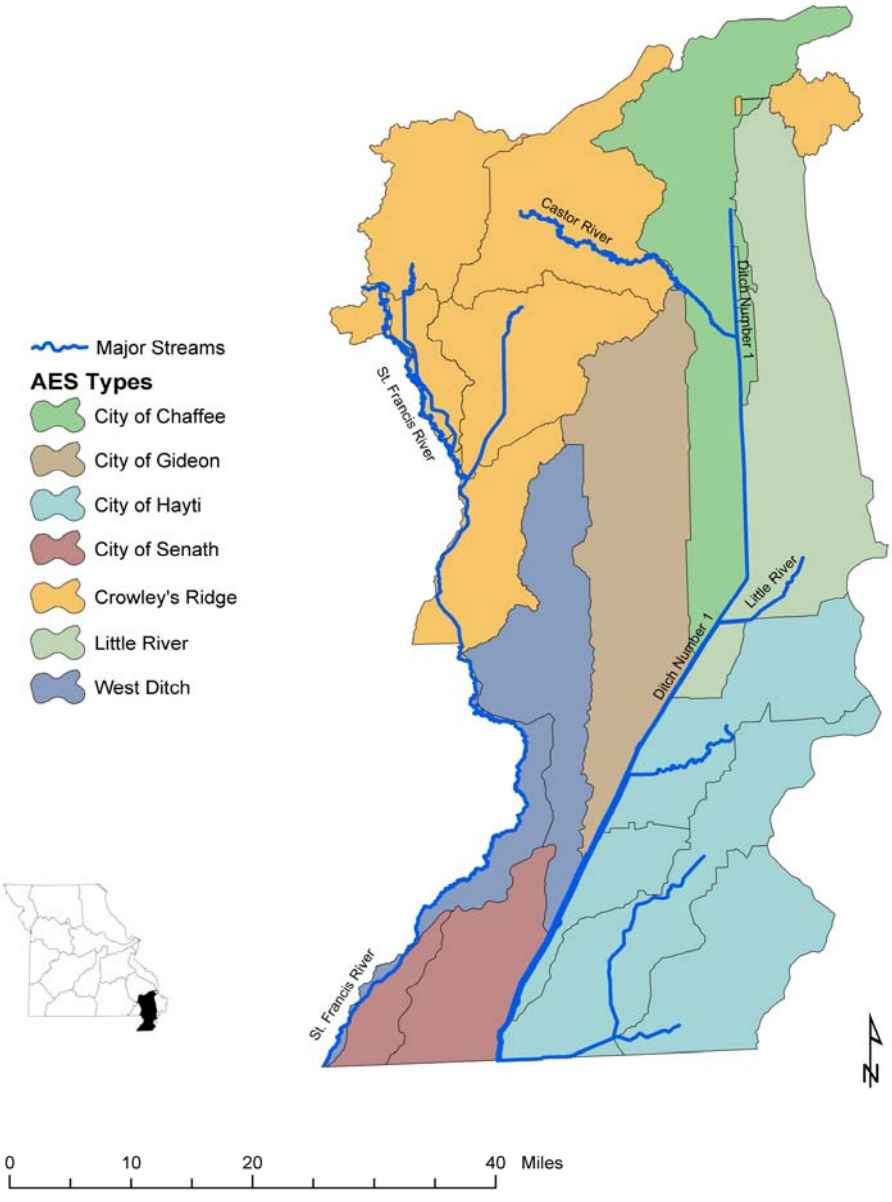


Figure 16. Map showing the boundaries and various Aquatic Ecological System Types for the St. Francis/Little Ecological Drainage Unit.

St. John's Bayou EDU

The St. John's Bayou EDU contains the many smaller direct tributaries to the Mississippi River between the outlet of the Headwater Diversion Channel near Cape Girardeau, MO and the outlet of the St. Francis River near Helena, Arkansas (Figure 17). Historically, these channels had an "intimate" relationship with the Mississippi River. These smaller streams were regularly flooded and resculpted by the Mississippi River. Natural levees interspersed with adjacent swamplands and marshes provided a diverse landscape for plant and wetland communities. These differences in landscape conditions are represented by 4 AES-Types that largely correspond to the Landtype Associations of Nigh and Schroeder (2002)(Figure 17). The connection with the Mississippi River is the reason this EDU is the most biologically diverse EDU within the MAB. A total of 145 fish, mussel, and crayfish species either inhabit or at one time inhabited the St. John's Bayou EDU, many of which are great river species.

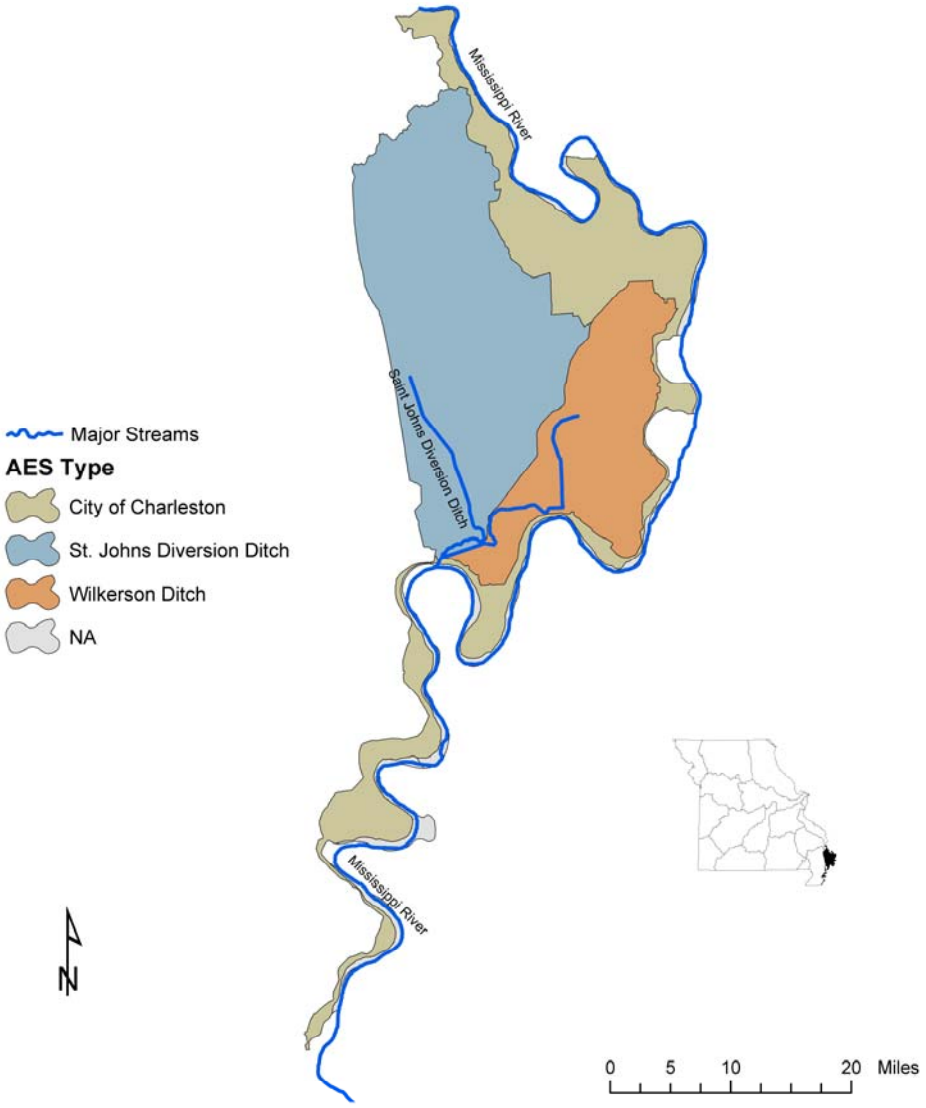
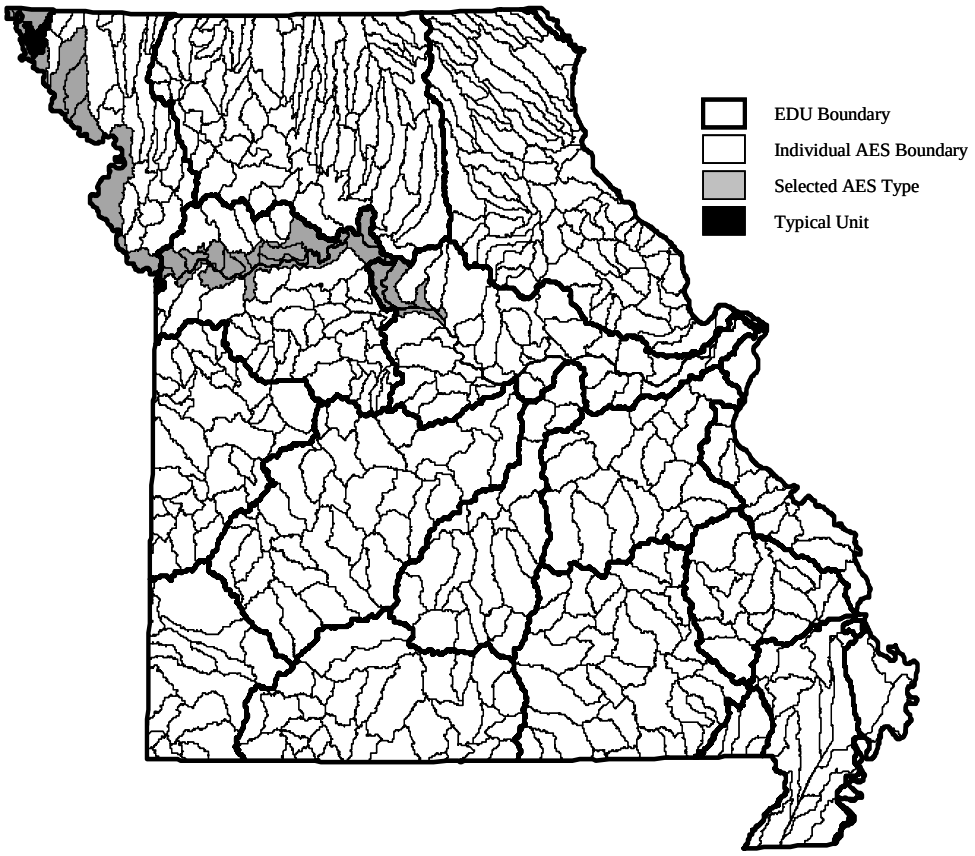


Figure 17. Map showing the boundaries and various Aquatic Ecological System Types for the St. John's Bayou Ecological Drainage Unit.

APPENDIX 3.3
Descriptions of Aquatic Ecological Systems Types (AES-Type) for Missouri

AES-Type 1 (Rock Creek)



Geographic location:
Primarily restricted to the Missouri River border in the Central Plains Aquatic Subregion, but with a small portion located along the Missouri River at the western end of the Ozarks.

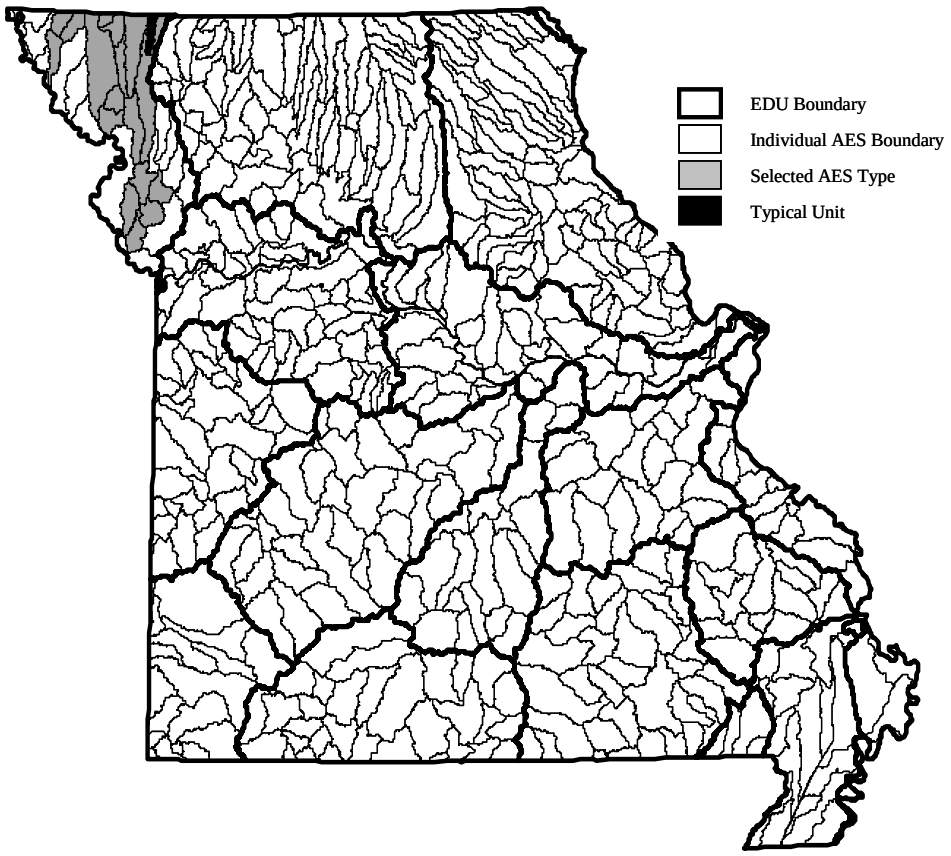
Ecological Drainage Units in Which This AES-Type Occurs:
Central Plains/ Nishnabotna/ Platte EDU
Central Plains/ Blackwater/ Lamine EDU
Ozark/ Moreau/ Loutre EDU

Description:
This AES-Type runs in a narrow band along the Missouri River from the northwest corner of Missouri to just below the outlet of Petite Saline Creek and contains much of the Missouri River floodplain and adjacent bluffs. Local relief ranges from nearly

zero within the floodplain to about 200 feet in the adjacent uplands and bluffs. The area consists mainly of the alluvial plain along the Missouri River that is composed of Pleistocene and Holocene alluvial materials with Pennsylvanian limestone and occasionally sandstone in the upland portions of this AES-Type. These older alluvial materials consist of gravel, sand, and silts and are overlain by more recent alluvium that is sandy and silty and generally not more than 150 years old. Bedrock is more than 30 feet below the surface. Surface soil textures consist primarily of silt loams and to a lesser extent silty clays. These soils exhibit varied infiltration rates ranging from moderate in the uplands to slow or even very slow in the alluvium of the Missouri River floodplain. Soils may be slightly alkaline. Historically the Missouri River was very meandering and frequently shifted its channel along with its bars and islands. Wetlands and oxbow lakes were once common here. There are 23 headwater/creek springs and no main stem springs scattered throughout the 24 individual units comprising this type. The median spring count is 0. Headwaters and creeks have a combined mean stream gradient of 8.1 meters per kilometer which is fairly low when compared with the AES-Types for the rest of Missouri.

Typical unit: 141 – Rock Creek

AES-Type 2 (Honey Creek)



Geographic location:
Restricted to the Central Plains Aquatic Subregion.

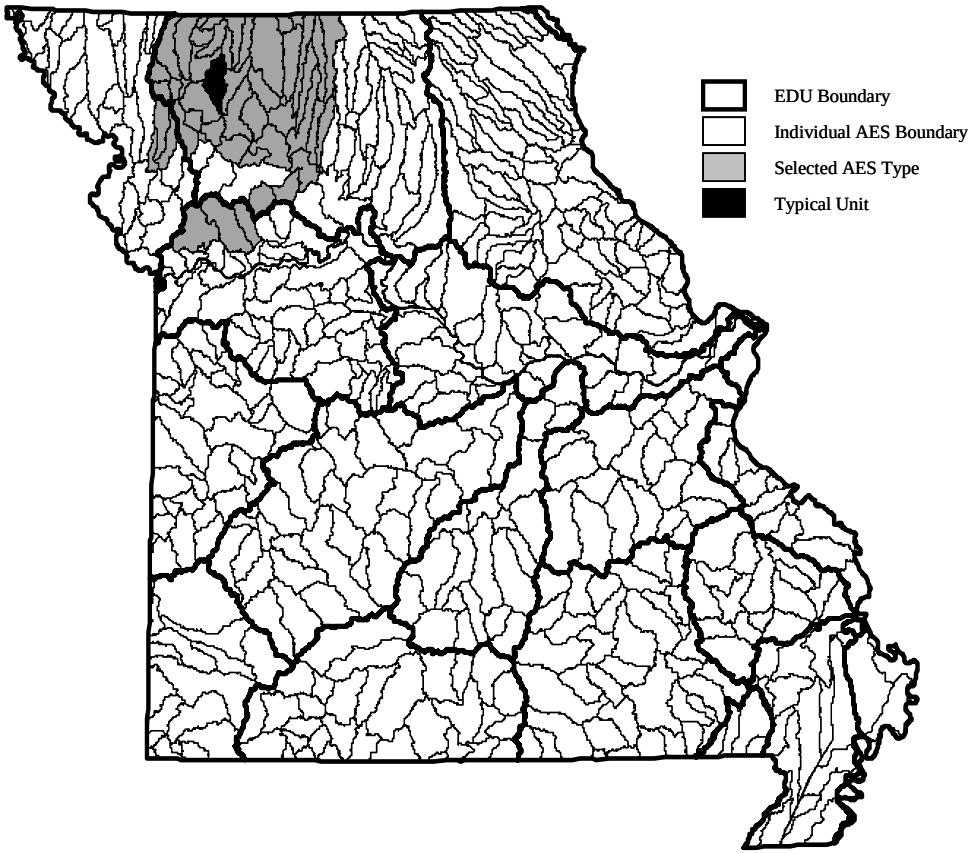
Ecological Drainage Units in Which This AES-Type Occurs:
Central Plains/ Nishnabotna/ Platte EDU

Description:
This AES-Type occurs in northwest Missouri within the Central Plains/Nishnabotna/Platte EDU. Local relief typically ranges from 50 to nearly 200 feet. Pennsylvanian limestone underlies most of the AES. Loess blankets glacial till throughout the region except where the loess has been removed by stream valley down-cutting and erosion. Soils here are very deep and exhibit moderate infiltration rates. Surface soil textures consist of silty clay loams and silty loams. Bedrock is exposed at the Missouri River bluffs while bedrock and glacial till may both be exposed in the deeper valleys. Headwaters and creeks within this AES-Type exhibit low gradients while the larger natural streams have very meandering courses and lower gradients with wide valleys in relation to stream size. Stream flows are highest in the spring and are at their lowest toward the end of summer occasionally going nearly dry during the driest periods. Springs are quite rare although groundwater is abundant albeit often saline. There are 27 headwater/creek springs and four main stem springs scattered throughout the 19 individual units comprising this type. The

median spring count is 0. Headwaters and creeks have a combined mean gradient of 9.4 meters per kilometer.

Typical unit: 144 – Honey Creek

AES-Type 3 (Sampson Creek)



Geographic location:
Restricted to the Central Plains Aquatic Subregion.

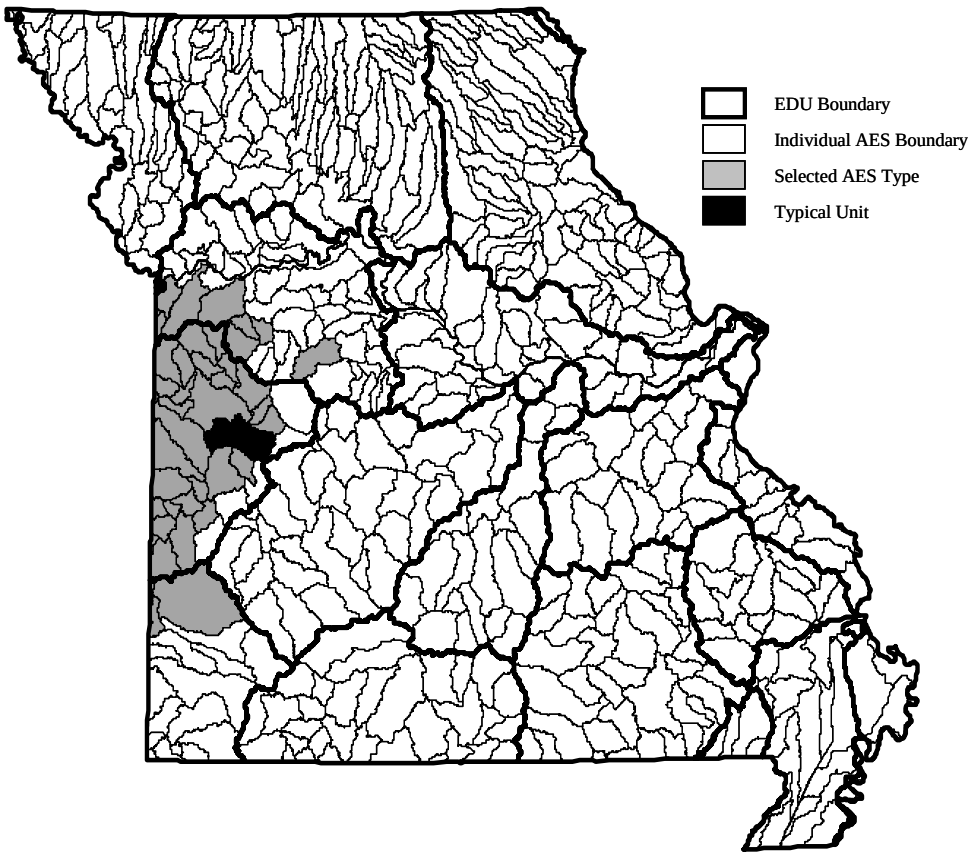
Ecological Drainage Units in Which This AES-Type Occurs:
Central Plains/ Nishnabotna/ Platte EDU
Central Plains/ Grand/ Chariton EDU
Central Plains/ Blackwater/ Lamine EDU

Description:
This AES-Type is one of the predominant Types of the Central Plains Aquatic Subregion and is essentially contained in one large cluster that incorporates most of the Grand River drainage and some south flowing tributaries to the Missouri River. Most local relief is between 50 and 200 feet. Bedrock geology within this AES-Type consists of Pennsylvanian limestone with some sandstone. Glaciation occurred throughout the entire area followed by the deposition of loess. Bedrock is exposed in areas where streams have down-cut through the loess and glacial till. Present day soils are a product of glacial drift and loess and subsequent weathering of these materials. Surface soil textures consist of clay loams and loams with slow to moderate infiltration rates. Soils closest to the stream channels are the sandiest with fairly high infiltration rates, while soils further from the streams contain more clay and

exhibit slower infiltrations. Stream valleys tend to be fairly wide for the size of the streams associated with them. Some areas exhibit very little stream dissection. Streams are highly meandering and exhibit fairly low gradients. Streams here often flood in conjunction with heavy rain events. Many of these streams may revert to a series of pools during prolonged dry periods. Stream substrates range from cobble and bedrock to sandy. Springs are not common and are typically small and often saline like the groundwater. There are 15 headwater/creek springs and two main stem springs scattered throughout the 49 individual units comprising this Type. The median spring count is 0. Headwaters and creeks have a combined mean gradient of 8.9 meters per kilometer. Historical vegetation consisted of prairie and timber that corresponded with the ridge and valley landscape patterns.

Typical unit: 496 – Sampson Creek

AES-Type 4 (South Deepwater Creek)



Geographic location:
Restricted to west-central Missouri, but found in both the Central Plains and Ozark Aquatic Subregions.

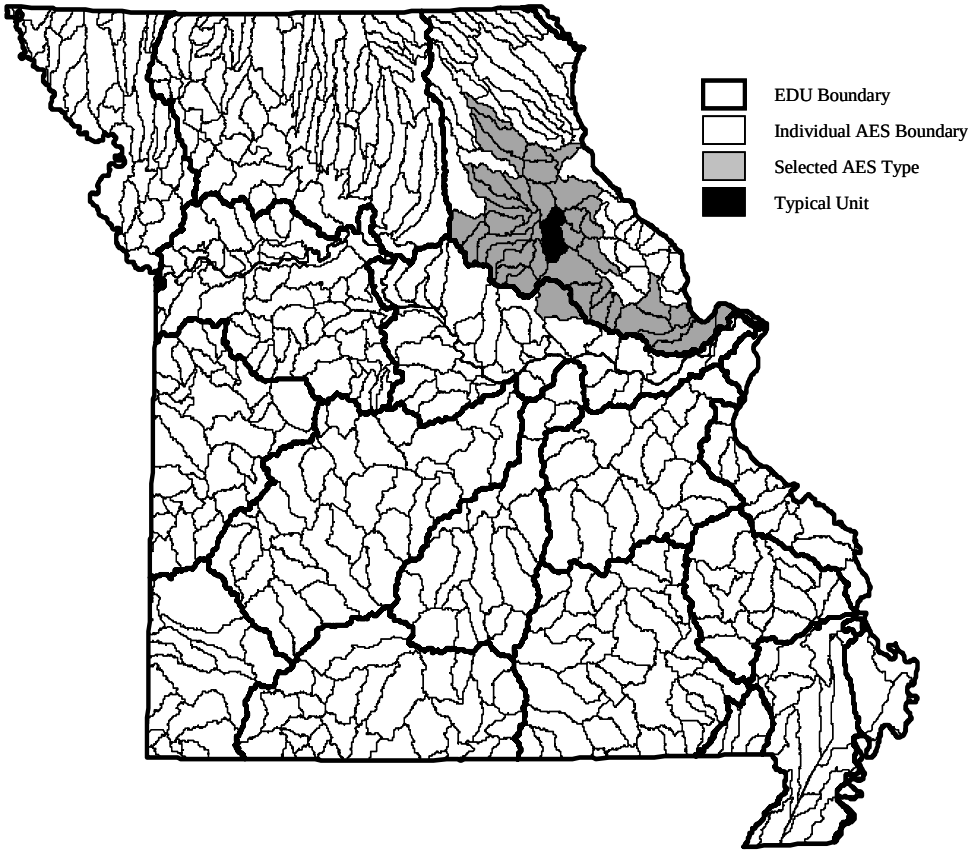
Ecological Drainage Units in Which This AES-Type Occurs:
Central Plains/ Blackwater/ Lamine EDU
Central Plains/ Osage/ South Grand EDU
Ozark/ Neosho EDU

Description:
This AES-Type is located in the west-central portion of Missouri's Central Plains Aquatic Subregion and ranges southward into the Ozark Aquatic Subregion to encompass the North Fork of the Spring River. Local relief is typically less than 200 feet. This area has not been glaciated and consists primarily of Pennsylvanian limestones and shales with lesser amounts of sandstone and coal in the north while the south consists of shales and sandstones. The relatively resistant limestone often forms escarpments. Soils are varied, but formed in loess or residuum and usually have loamy or clayey subsoils. Surface soil textures are variable, primarily consisting of silty loams or loams and are occasionally clayey. These soils exhibit very slow to slow or even moderate infiltration rates. Small streams are typically intermittent while the larger ones are perennial, but have variable flows that may be seriously reduced in the dry summer months. These streams are naturally very meandering. In some

places the streams may flow over bedrock. Sand and silt are the most common substrates, but gravel, cobble and bedrock are also present in some areas. Groundwater is typically saline. There are 18 headwater/creek springs and one main stem spring scattered throughout the 46 individual units comprising this AES-Type. The median spring count is 0. Headwaters and creeks have a relatively typical combined mean gradient of 6.2 meters per kilometer. Historically, the natural vegetation consisted of prairie with some timber along the valleys.

Typical unit: 160 – South Deepwater Creek

AES-Type 5 (Lick Creek)



Geographic location:
Restricted to northeast Missouri and found primarily in the Central Plains, but also found in one EDU of the Ozarks.

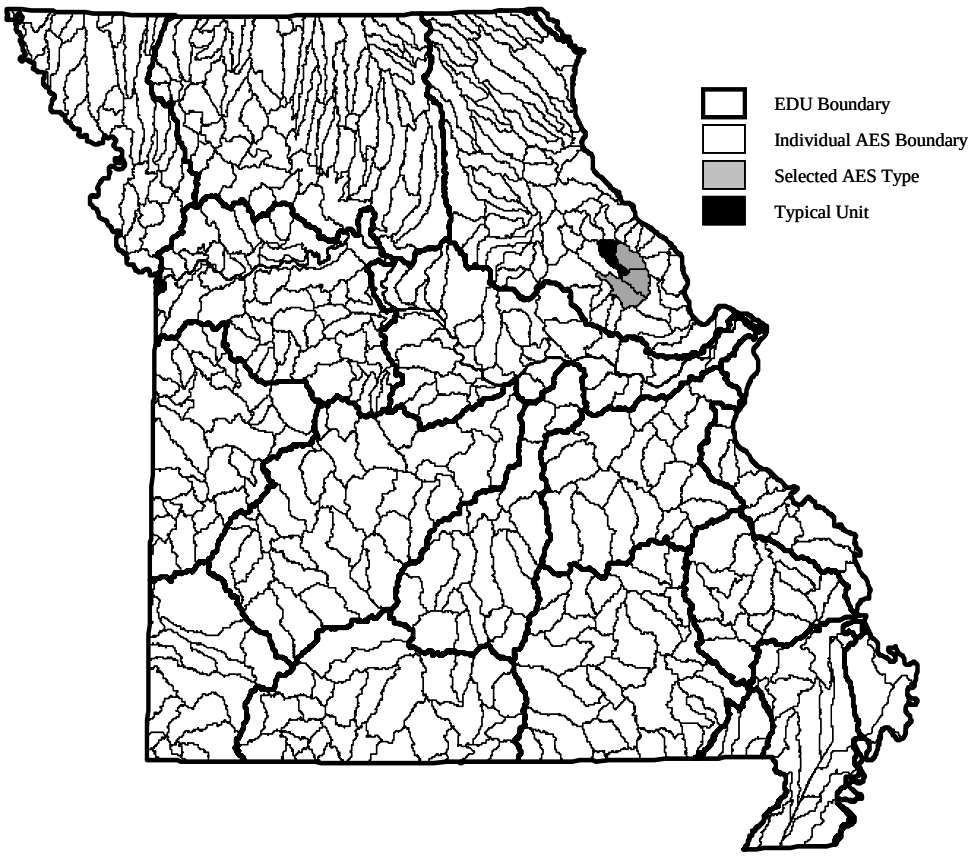
Ecological Drainage Units in Which This AES-Type Occurs:
Central Plains/ Cuivre/ Salt EDU
Ozarks/ Moreau/ Loutre EDU

Description:
This AES-Type is located primarily in the northeast Central Plains Aquatic Subregion. The western, or headwater, portions of this AES-Type consist of Pennsylvanian limestones that transition to Mississippian limestone nearer the Mississippi River. These bedrocks are rarely exposed because of thick overlying deposits of glacial till. The area can be characterized as having well developed claypan soils on a flat to gently rolling plain. Most local relief is less than 100 feet, but occasionally approaches 200 feet. The upland areas of this Type exhibit very low relief while the areas around the main stem rivers are much more rugged. Stream dissection is very minimal making for a very large area of low relief. Soils are deep and poorly drained and harbor perched water tables in the winter and spring resulting from the clay subsoils. Surface soil texture consists of silt loams with variable infiltration that ranges from very slow to moderate. Stream channels are typically in silts and clays and are meandering low gradient systems with narrow floodplains. The smaller

streams are intermittent or ephemeral while the large streams are perennial, but may have very low flows with disconnected pools during extended dry periods. Springs are small and uncommon while the groundwater is often saline. The eastern, or downstream, portions of this AES-Type consist of a similar environment as that of the Ozark border areas with Ordovician sandstones and limestones and notable karst features like sinkhole ponds. Topography can range from rolling to rugged. Soils are variable in relation to parent materials. Moderate gradient stream channels may encounter bedrock in some locations. There are 45 headwater/creek springs and five main stem springs scattered throughout the 41 individual units comprising this Type. The median spring count is 0. The combined headwater and creek median gradient is 7.4 meters per kilometer. Historically this area was primarily prairie with timber along stream valleys especially the downstream portions of the larger rivers.

Typical unit: 230 – Lick Creek

AES-Type 6 (Upper Cuivre River)



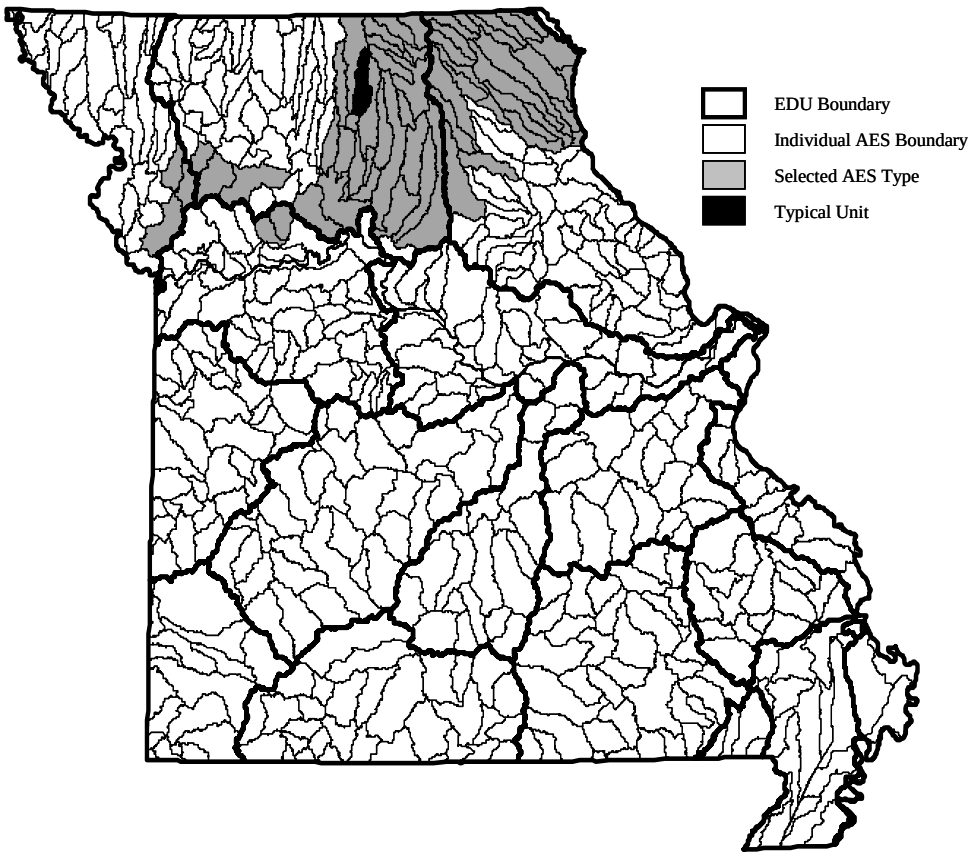
Geographic location:
Restricted to one EDU within the Central Plains Aquatic Subregion.

Ecological Drainage Units in Which This AES-Type Occurs:
Central Plains/ Cuivre/ Salt EDU.

Description:
This AES-Type consists of four relatively small units located in the Cuivre River drainage of the Central Plains. Local relief is less than 200 feet. The surface soil textures are predominantly silt loams with very slow or occasionally moderate infiltration rates. These soils are underlain by Mississippian and Ordovician limestones with small sandstone components. Coldwater is an important ecological feature of this Type. There are 75 headwater/creek springs and 14 main stem springs scattered throughout the four individual units comprising this AES-Type. The median spring count is 20.

Typical unit: 213 - Upper Cuivre River

AES-Type 7 (East Locust Creek)



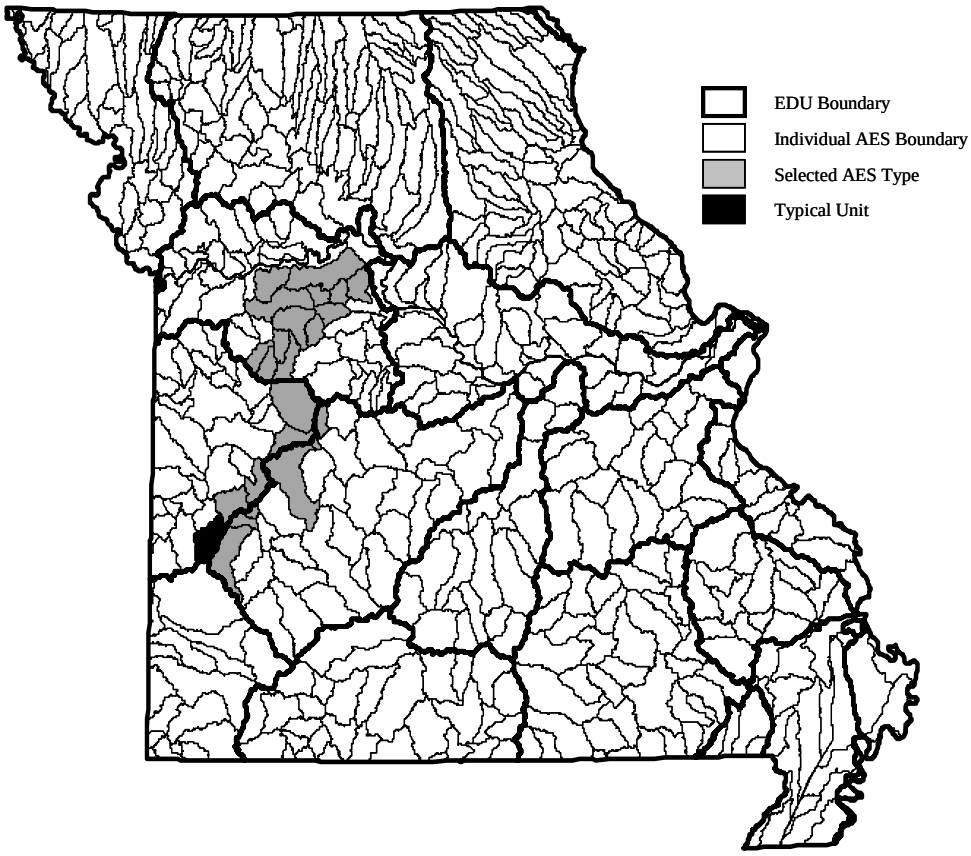
Geographic location:
Restricted to the Central Plains Aquatic Subregion.

Ecological Drainage Units in Which This AES-Type Occurs:
Central Plains/ Nishnabotna/ Platte EDU
Central Plains/ Grand/ Chariton EDU
Central Plains/ Cuivre/ Salt EDU
Central Plains/ Blackwater/ Lamine EDU

Description:
This is one of the dominant AES-Type of the Central Plains Aquatic Subregion and is concentrated in the central and northeast portion of the Central Plains. Local relief is less than 200 feet. Surface soil textures are principally loams and silty loams, or occasionally silty clay loam. Infiltration rates are typically slow, but variable ranging from moderate to very slow. Bedrock geology consists of limestone and sometimes sandstone. Like most of the Central Plains, springs are relatively uncommon. There are 21 headwater/creek springs and three main stem springs scattered throughout the 59 units comprising this AES-Type. The median spring count is 0.

Typical unit: 71 – East Locust Creek

AES-Type 8 (Clear Creek)



Geographic location:
Primarily restricted to the Central Plains and Ozark Aquatic Subregion border area in west-central Missouri.

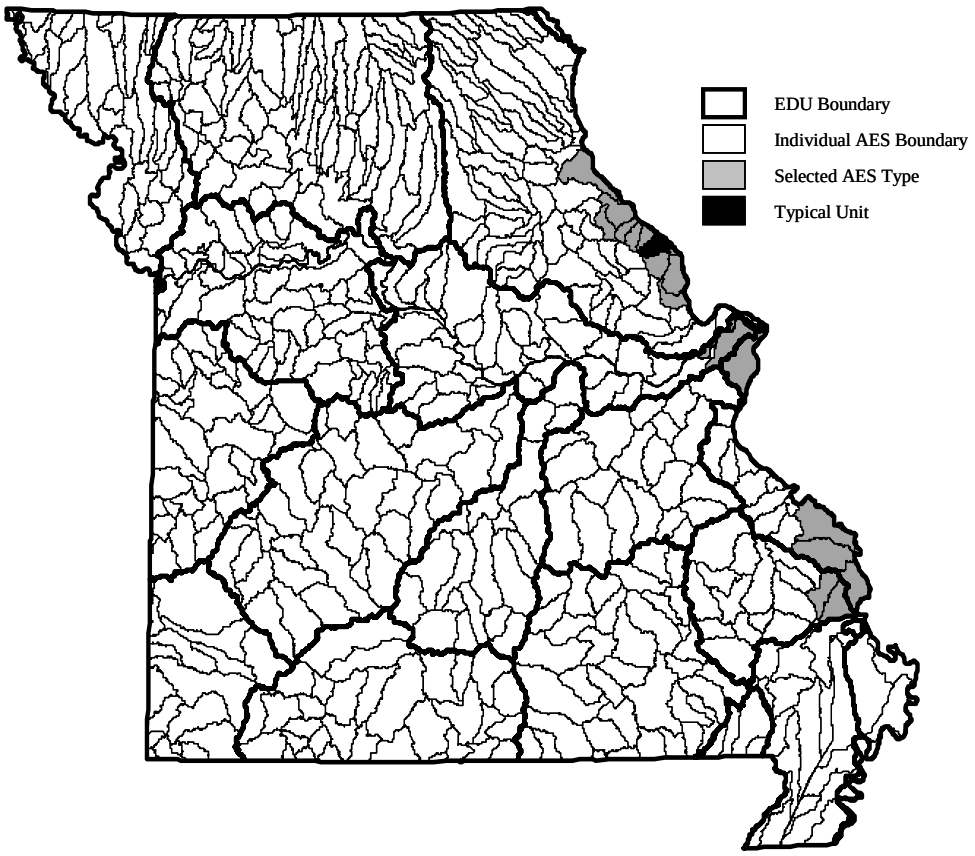
Ecological Drainage Units in Which This AES-Type Occurs:
Central Plains/ Blackwater/ Lamine EDU
Central Plains/ Osage/ South Grand EDU
Ozark/ Osage EDU

Description:
This AES-Type runs in a belt along the transition between the Central Plains and the Ozarks beginning in west-central Missouri and continuing in a northeasterly direction to include much of the upper Blackwater River basin. Local relief ranges from nearly zero to almost 200 feet, although most is between 50 and 100 feet. Much of the AES is a very flat plain that, historically, was prairie. Bedrock geology is generally Pennsylvanian limestone. Bedrock outcrops exists, albeit rarely, on some of the valley walls. Surface soil textures consist primarily of silty loams and loams with moderate to sometimes very slow infiltration rates. Streams are generally low gradient meandering systems in broad valleys and have their highest flows in the spring and lowest in the late summer occasionally going nearly dry during dry periods. Springs are not common, but groundwater is abundant and often saline.

There are 32 headwater/creek springs and ten main stem springs scattered throughout the 23 individual units comprising this AES-Type. The median spring count is 1. Headwaters and creeks combined have a mean gradient of 7.5 meters per kilometer. Historic vegetation was primarily prairie.

Typical unit: 189 – Clear Creek

AES-Type 9 (Ramsey Creek)



Geographic location:
Restricted to the eastern edge of Missouri along the Mississippi River. Found in both the Central Plains and the Ozark Aquatic Subregions.

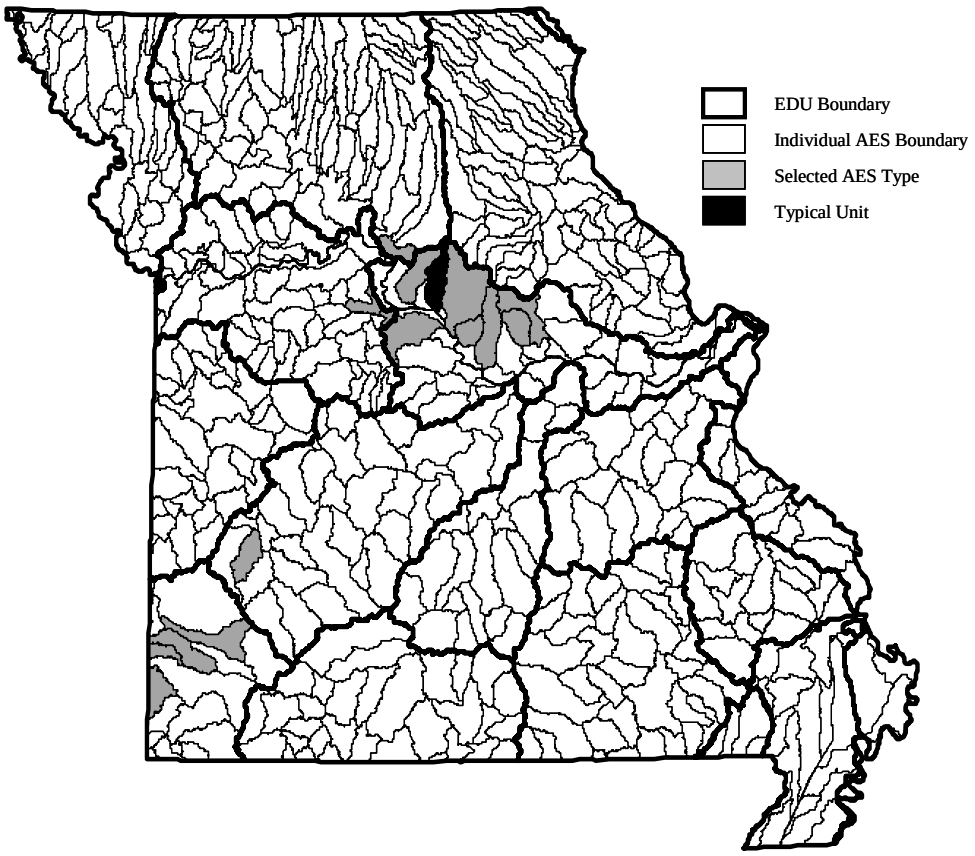
Ecological Drainage Units in Which This AES-Type Occurs:
Central Plains/ Cuivre/ Salt EDU
Ozark/ Moreau/ Loutre EDU
Ozark/ Apple/ Joachim EDU
Ozark/ Upper St. Francis/ Castor EDU

Description:
This AES-Type occurs in three separate patches along the Mississippi River in both the Central Plains and Ozark Aquatic Subregions from the North Fabius River to the Castor River Diversion Channel. This AES-Type consists of an Ozark border type environment and contains many small tributaries to the Mississippi River that begin on the bluffs and flow down across the Mississippi River floodplain. The mouth of the Missouri River is included in this Type. Local relief varies from nearly zero in the floodplain of the Mississippi River to occasionally more than 300 feet in the bluffs further from the river. Rock types are varied, but are mostly cherty dolomites to the south and Ordovician sandstones and limestones to the north. Karst features exist throughout the AES-Type. Soils are diverse and variable depending on the parent material from which they were formed and their position in the landscape. Surface

soil textures typically consist of silt loams and silty clays with moderate to slow or very slow infiltration rates. The soils are underlain primarily by limestone in the bluffs with alluvium along the river. Hydrologically this area is relatively diverse. Most streams are headwaters and creeks that are deeply incised with gravel substrates that flow directly to the Mississippi River. Flows are highest in the spring and lowest in the fall. Backflooding occurs when the Mississippi River is high. Springs are not an important feature here, but groundwater is abundant. There are 64 headwater/creek springs and six main stem springs scattered throughout the 17 individual units comprising this AES-Type. The median spring count is 2. The headwaters and creeks combined have a fairly typical mean gradient of 10.1 meters per kilometer. The historic vegetation consisted largely of oak and mixed-hardwood woodland and forest.

Typical unit: 252 – Ramsey Creek

AES-Type 10 (Moniteau Creek)



Geographic location:
Restricted primarily to the Ozark Aquatic Subregion, but is also found in the lower Little Chariton and lower Lamine basins on the Central Plains Aquatic Subregions.

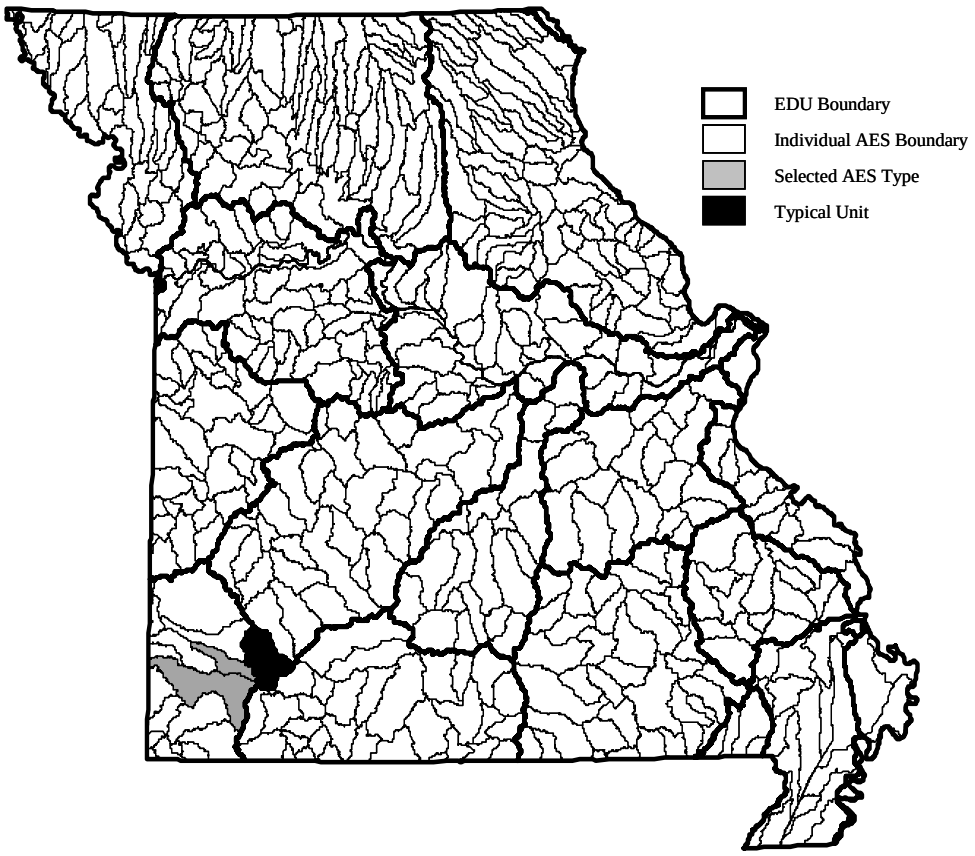
Ecological Drainage Units in Which This AES-Type Occurs:
Central Plains/ Grand/ Chariton EDU
Central Plains/ Blackwater/ Lamine EDU
Ozark/ Moreau/ Loutre EDU
Ozark/ Osage EDU
Ozark/ Neosho EDU

Description:
This AES-Type occurs in two general clusters in the Ozarks and in a small part of the Central Plains of Missouri. Local relief varies from nearly zero to almost 200 feet. Bedrock consists primarily of cherty limestones, Pennsylvanian to the north and Mississippian to the south. Karst features are scattered throughout the AES-Type and sinkholes are quite common. Surface soil textures are primarily loams or silt loams with slow to moderate infiltration rates, although very slow infiltration rates are occasionally present. Soils in the north are diverse depending on parent material and formed in deep loess. Silty loess deposits are thickest near the Missouri River and thinner moving away from the river. In the southern cluster of this AES-Type soils formed in weathered cherty limestones with loess surfaces and are moderately

to very deep. Throughout the AES-Type stream flows are highest in the spring and lowest in the fall. Stream bed loads are of gravel and sand. Groundwater is abundant. There are 24 headwater/creek springs and two main stem springs scattered throughout the 16 individual units comprising this AES-Type. The median spring count is 1. The combined headwater and creek mean gradient is fairly low at 9.1 meters per kilometer.

Typical unit: 386 – Moniteau Creek

AES-Type 11 (Upper Spring River of the Neosho)



Geographic location:
Restricted to the Ozark Aquatic Subregion.

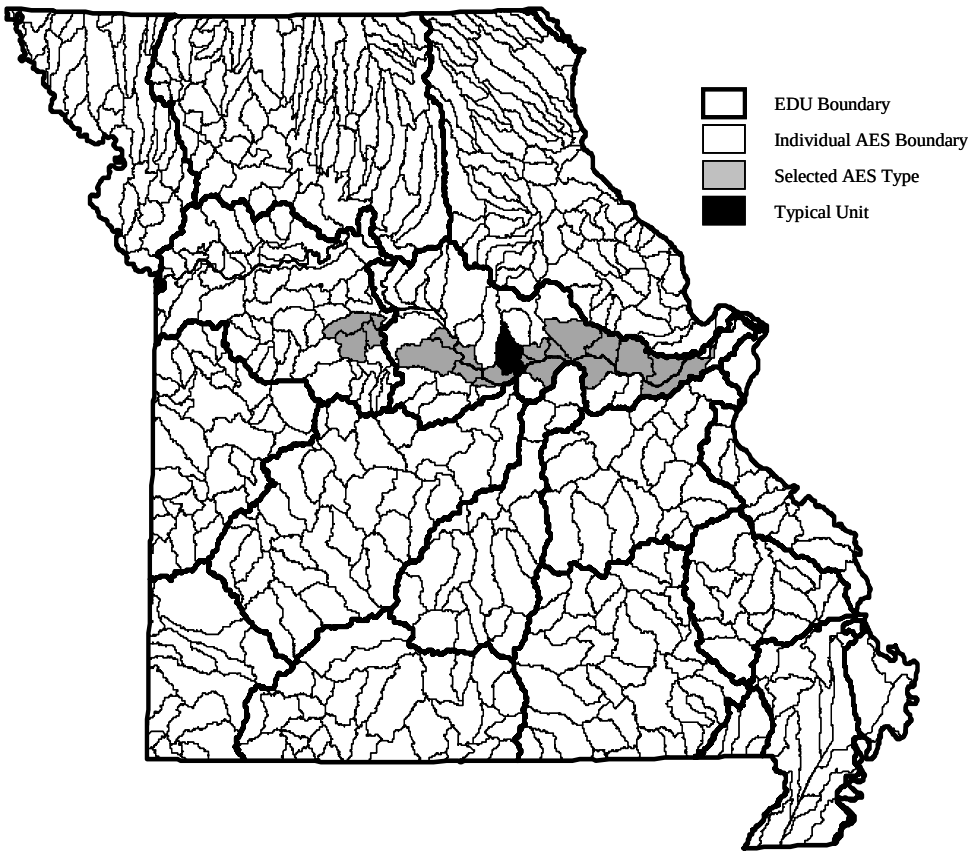
Ecological Drainage Units in Which This AES-Type Occurs:
Ozark/ Neosho EDU.

Description:
This AES-Type is located within the Ozark/Neosho EDU in southwestern Missouri. Local relief is generally less than 100 feet, but will occasionally approach 200 feet. Mississippian period cherty limestones underlie deep soils that formed in this weathered cherty limestone covered with loess. Surface soil textures consist of loams and silty loams with slow to moderate infiltration rates. Karst features are prominent, especially notable are the large number of springs and sinkholes that dot the AES-Type. Stream discharges are highest in the spring and lowest in the fall and flash floods are common after large rain events. Streams generally carry bed loads of cherty gravel and sand. Coldwater is an important ecological feature in this Type. Because springs are abundant and often large they contribute to maintaining stream base flows. Groundwater is usually abundant and of good quality. There are 101 headwater/creek springs and 15 main stem springs scattered throughout the three individual units comprising this AES-Type. This AES-Type contains two springs over 10 cfs. The median spring count is 14. The combined headwater and creek mean

stream gradient is relatively low at 8.7 meters per kilometer. Historic vegetation was principally prairie with timber found along streams.

Typical unit: 316 – Upper Spring River of the Neosho drainage

AES-Type 12 (Middle River)



Geographic location:
Restricted to a band running roughly east-west in central Missouri largely along the lower portion of the Missouri River. Found in both the Central Plains and Ozark Aquatic Subregions.

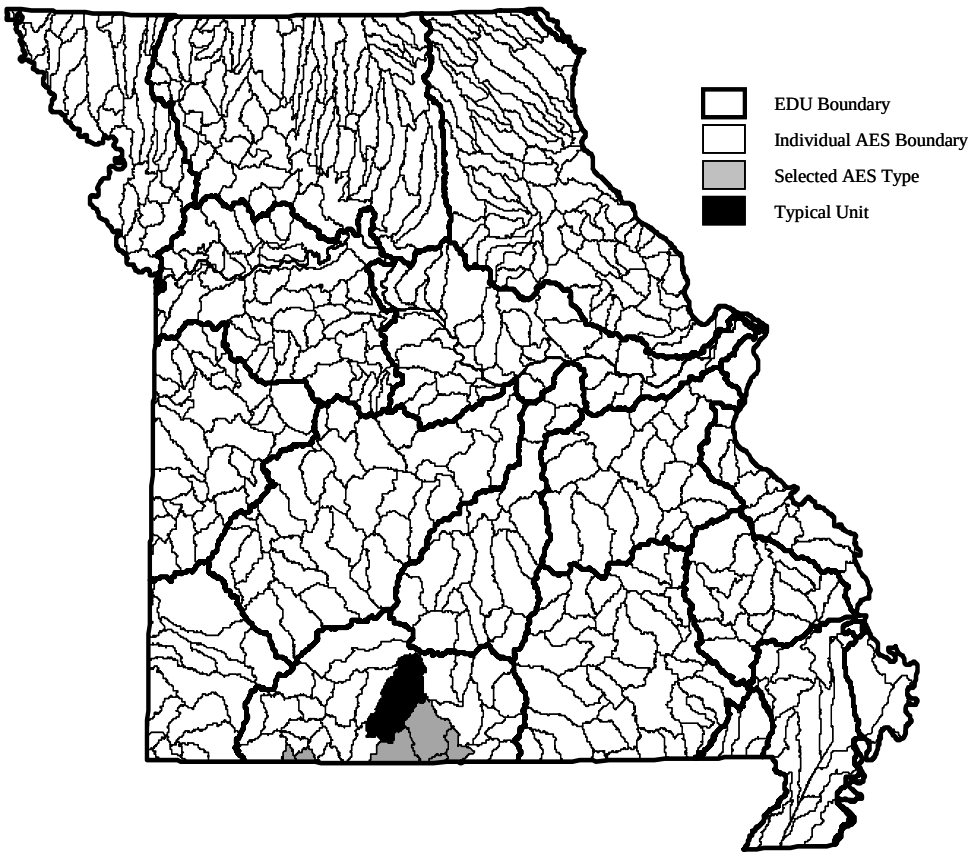
Ecological Drainage Units in Which This AES-Type Occurs:
Central Plains/ Blackwater/ Lamine EDU
Ozark/ Moreau/ Loutre EDU

Description:
This AES-Type is located along much of the lower Missouri River and much of the lower Lamine River and several of its tributaries including Muddy and Heaths Creeks. Local relief ranges from nearly zero along the Missouri River floodplain to 200 or even 300 feet at the edge of the floodplain. Bedrock is often exposed in this area and consists of varied rock types including Pennsylvanian cherty limestones and cherty dolomites of the Ordovician Jefferson City-Cotter Formation. Karst features occur, but are not abundant. Alluvial areas adjacent to the Missouri River have deep silty loess deposits that become thinner moving away from the river. Soil diversity is high and varies with landscape position and parent material. Surface soil textures consist of loams and stony soils with moderate to very slow infiltration rates. The area is hydrologically diverse with lots of small moderate gradient streams draining directly to the Missouri River. Bed materials are usually in gravel and sand except

approaching the Missouri River where bed materials become silty. Stream flows are highest in the spring and lowest in the fall. Flash floods occur after heavy rain events. Springs have minimal impact on stream base flows. Groundwater is abundant. There are 54 headwater/creek springs and three main stem springs scattered throughout the 14 individual units comprising this AES-Type. The median spring count is 1. The combined headwater and creek mean stream gradient is relatively average at 12.6 meters per kilometer. Historic vegetation was largely oak savanna.

Typical unit: 391 – Middle River

AES-Type 13 (Beaver Creek)



Geographic location:
Restricted to one EDU within the Ozark Aquatic Subregion.

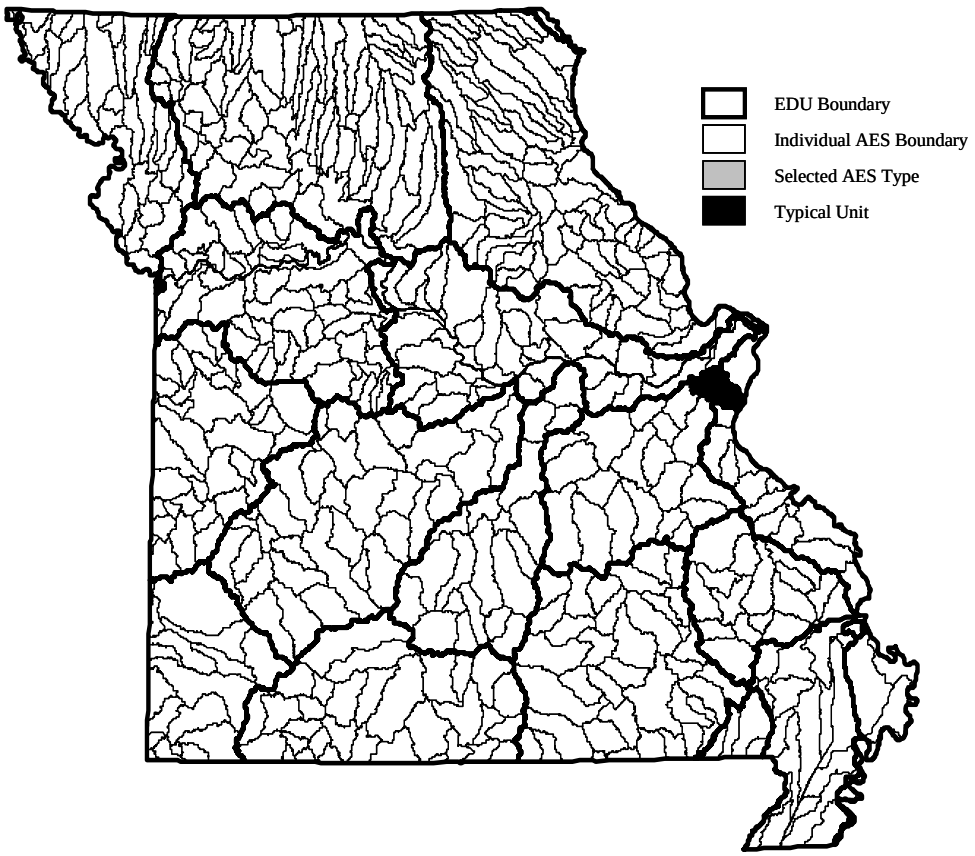
Ecological Drainage Units in Which This AES-Type Occurs:
Ozark/ White EDU

Description:
This AES-Type is located within the White River drainage of the Ozark Aquatic Subregion. Local relief is primarily between 50 and 400 feet. The area is underlain by cherty and shaley dolomites of the Ordovician Jefferson City Cotter Formation. Ridges are more apt to be underlain by limestones of the Mississippian series. Because of the solubility of these rocks karst features are fairly prominent. The surface materials here are clayey and contain lots of chert rock fragments. Soils are the result of weathered dolomites and limestones. Surface soil textures consist of cherty, stony, and silt loam soils. Soil infiltration rates are primarily slow to moderate. Streams exhibit high gradients with bedloads of sand and gravel that form bars and flow through relatively narrow floodplains. Stream flows are highest in late winter and early spring and diminish through the summer to their lowest flows in the fall. Headwater streams may often be dry and lose much of their flow to groundwater as a result of the abundant karst. Flash floods are common after heavy rain events. Stream base flows are maintained to some degree by springs in the area. There are 60 headwater/creek springs and one main stem spring scattered throughout the eight

individual units comprising this type. The median spring count is 1. The combined headwater and creek mean stream gradient is 17.5 meters per kilometer. Historic vegetation was oak woodland and glade woodland complexes.

Typical unit: 470 – Beaver Creek

AES-Type 14 (Lower Meramec)



Geographic location:
Restricted to the Ozark Aquatic Subregion.

Ecological Drainage Units in Which This AES-Type Occurs:
Ozark/ Meramec EDU.

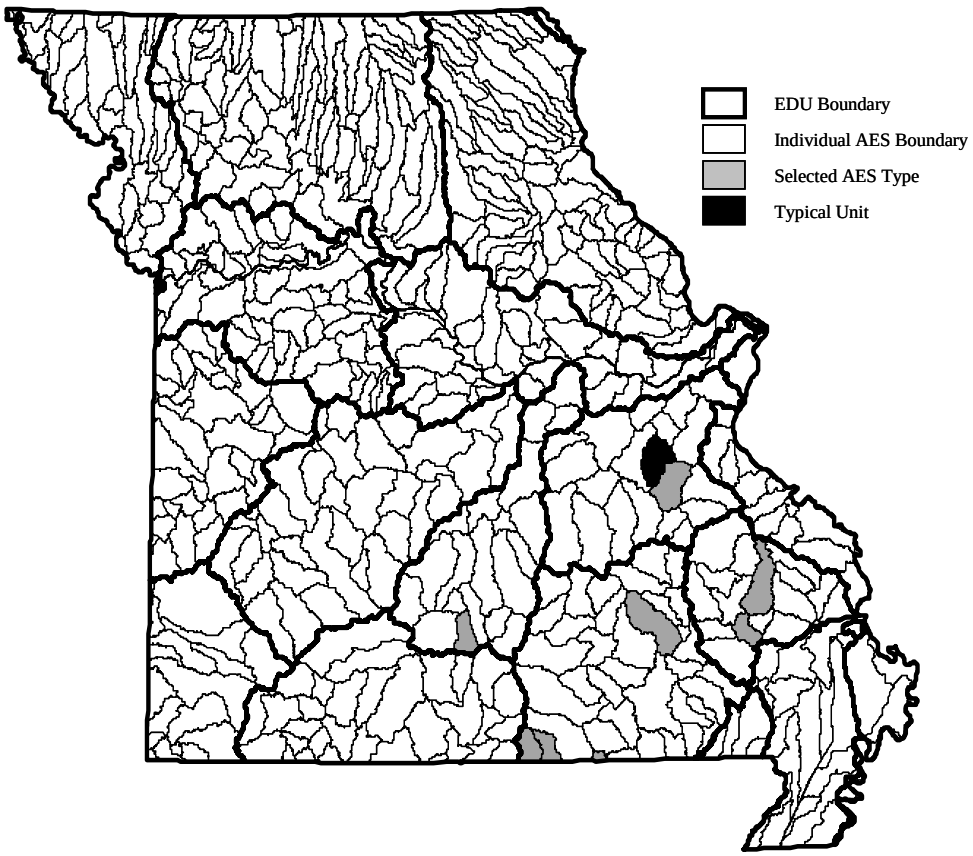
Description:
This AES-Type consists of only one small unit in the Ozarks at the mouth of the Meramec River. This AES-Type exhibits local relief of less than 300 feet. Surface soils consist primarily of silty loams with moderate to slow infiltration rates. The area is composed of Mississippian limestones and Ordovician dolomite, shale and sandstone. There are significant karstic areas with most springs located in the western portion of the unit and most of the sinkholes located in the north and east. The landscape varies from moderately rugged to rugged. Springs are relatively common making coldwater an important ecological feature of this Type. There are 68 headwater/creek springs and one main stem spring scattered throughout the one individual unit comprising this type. The combined headwater and creek mean stream gradient is 15.8 meters per kilometer. Historically, the area was dominated by oak and mixed hardwood forests.

This unit receives the drainage from the entire Ozark/ Meramec EDU. Considering the Ozark/ Meramec EDU in its entirety will reveal that local relief is generally

between 50 and 300 feet. Surface soil texture consists chiefly of silty loams, but also of cherty soils. Soil infiltration rates are typically slow. The soils are underlain by varied geology consisting of dolomite and sandstone with much smaller components of limestone and igneous rock.

Typical unit: 374 - Lower Meramec

AES-Type 15 (Indian Creek)



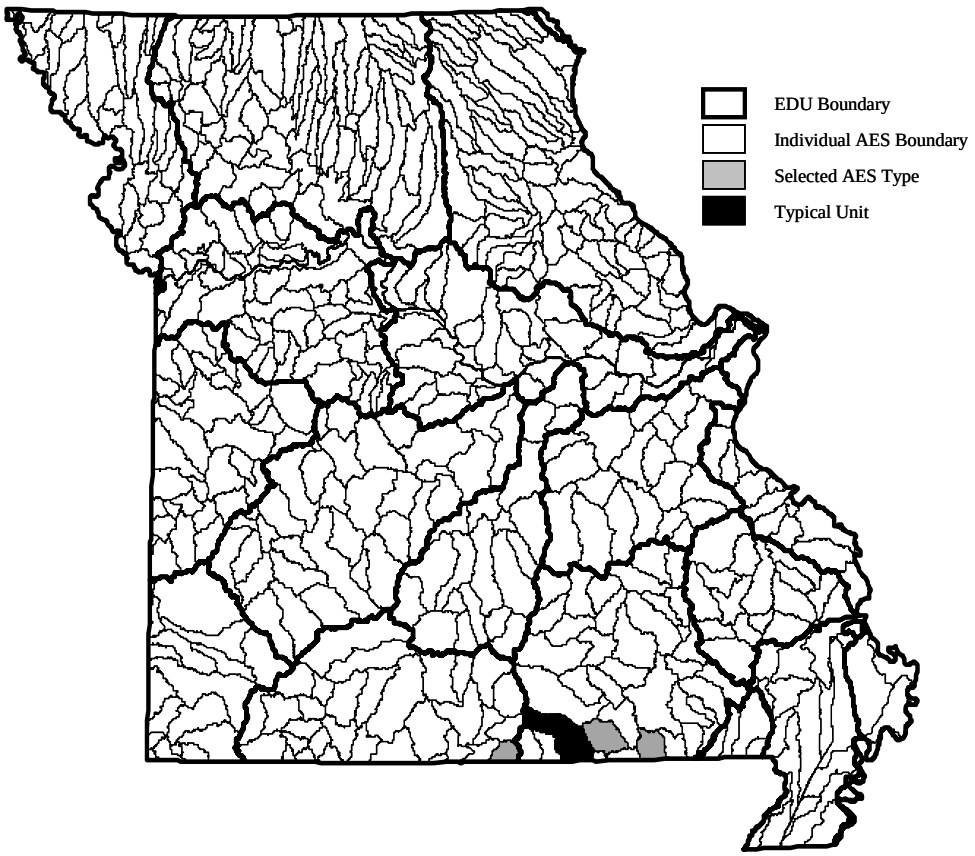
Geographic location:
Scattered throughout the southeastern portion of the Ozark Aquatic Subregion.

Ecological Drainage Units in Which This AES-Type Occurs:
Ozark/ Meramec EDU
Ozark/ Upper St. Francis/ Castor EDU
Ozark/ Black/ Current EDU
Ozark/ Gasconade EDU

Description:
This AES-Type is scattered in small patches throughout the eastern Ozarks. Local relief ranges from 50 to nearly 300 feet. Surface soil textures are cherty and exhibit moderate infiltration rates. These soils are underlain by dolomite or occasionally sandstone. Springs are relatively common with 65 headwater/creek springs and seven main stem springs scattered throughout the nine individual units comprising this AES-Type. The median spring count is 9. The combined headwater and creek mean stream gradient is 14.3 meters per kilometer.

Typical unit: 361 – Indian Creek

AES-Type 16 (Spring River of the Eleven Point)



Geographic location:
Restricted to the south-central portion of the Ozark Aquatic Subregion.

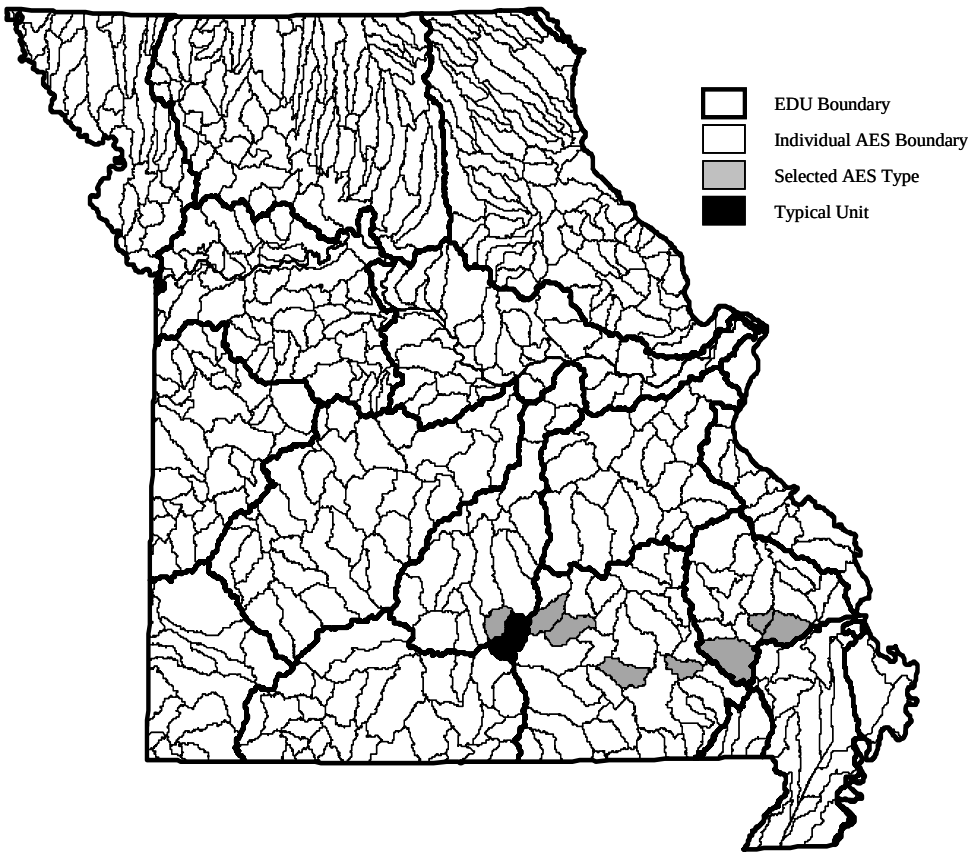
Ecological Drainage Units in Which This AES-Type Occurs:
Ozark/ Black/ Current EDU
Ozark/ White EDU

Description:
This AES-Type is located in the southern Ozark Aquatic Subregion along the Missouri-Arkansas border. Local relief is mainly between 50 and 200 feet. The area is underlain by carbonate bedrock consisting primarily of the Jefferson City-Cotter dolomite and contains lots of karstic features. Minor sandstone components are also present along stream valleys. Soils consist largely of deep cherty loams, but are variable in nature with moderate infiltration rates. Stream flows are highest in the late winter and into early spring, but dwindle to a series of disconnected pools during the dry summer months. Although springs are quite common, most of them are small in this AES-Type. Some areas serve as a groundwater source for springs in adjacent valleys. Coldwater may be an important ecological feature of this Type. Springs are very common with 98 headwater/creek springs and 3 main stem springs scattered throughout the four individual units comprising this AES-Type. The median spring count is 20.5. The combined headwater and creek mean gradient is fairly average at

13.5 meters per kilometer. Historically the area was vegetated by mixed oak woodland with some prairie and savanna.

Typical unit: 274 – Spring River of the Eleven Point Drainage

AES-Type 17 (Upper Big Piney)



Geographic location:
Restricted to the Ozark Aquatic Subregion.

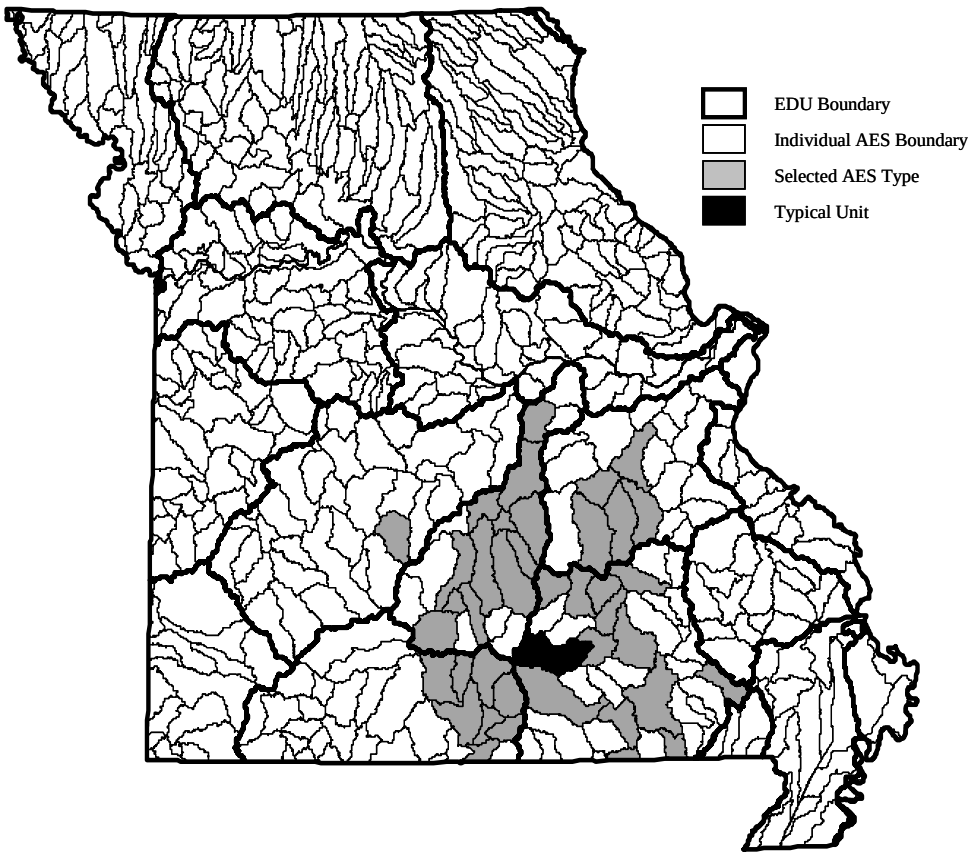
Ecological Drainage Units in Which This AES-Type Occurs:
Ozark/ Upper St. Francis/ Castor EDU
Ozark/ Black/ Current EDU
Ozark/ Gasconade EDU

Description:
This AES-Type is found scattered throughout the southeast part of the Missouri Ozarks. Local relief is concentrated between 100 and 200 feet, but does range from nearly zero to over 300 feet to a lesser degree. Bedrock geology consists of Ordovician dolomite and sandstone with residuum that contains significant chert fragments. Karst features (sinkholes and springs) are scattered inconsistently across the AES-Type. Surface soil textures are cherty and/or loamy with moderate to slow infiltration rates. Streams carry bed loads of sand and gravel that form bars. Little suspended sediment is carried by these streams. Flash floods may occur after heavy rain events. Springs are relatively common and some contribute notably to the base flow of streams. Groundwater is abundant although often alkaline. There are 32 headwater/creek springs and five main stem springs scattered throughout the nine individual units comprising this AES-Type. This AES-Type contains one spring over

10 cfs. The median spring count is 3. The combined headwater and creek mean stream gradient is 13.0 meters per kilometer.

Typical unit: 327 – Upper Big Piney River

AES-Type 18 (Jacks Fork)



Geographic location:
Restricted to the southcentral portion of the Ozark Aquatic Subregion.

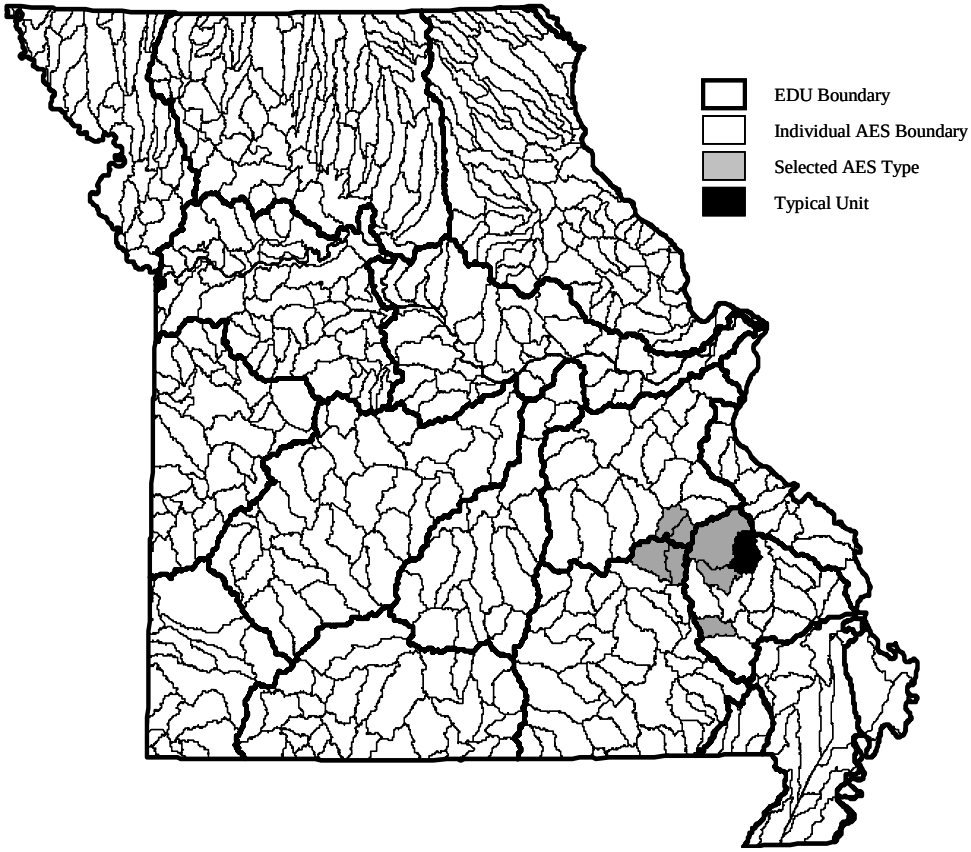
Ecological Drainage Units in Which This AES-Type Occurs:
Ozark/ Osage EDU
Ozark/ Gasconade EDU
Ozark/ Meramec EDU
Ozark/ Black Current EDU
Ozark/ White EDU

Description:
This AES-Type is represented by much of the heart of the Ozarks in Missouri and covers a wide geographic area. Local relief varies and is concentrated between 100 and 300 feet, but often approaches 500 feet. Bedrock geology consists primarily of cherty dolomites and sandstone from the Gasconade and Roubidoux Formations of the early Ordovician. Karst features are quite common. Soils are formed in weathered bedrock and rock fragments are numerous. Surface soil textures consist of cherty soils and silt loams with moderate to slow infiltration rates. Streams typically have relatively high gradients, low suspended sediment and carry bed loads of sand and gravel that form bars. Flash flood events may occur after heavy rainfall events. Groundwater is abundant, but often alkaline. Springs are numerous making coldwater is an important ecological feature of this AES-Type. There are 968

headwater/creek springs and 126 main stem springs scattered throughout the 40 individual units comprising this Type. This AES-Type contains 39 of the largest 47 springs (springs over 10 cfs) in Missouri. The median spring count is 25.5. The combined headwater and creek mean stream gradient is relatively high at 17.4 meters per kilometer. Historic vegetation was largely mixed-oak and oak-pine woodland or forest.

Typical unit: 291 – Jacks Fork River

AES-Type 19 (Little St. Francis River)



Geographic location:
Restricted to the Ozark Aquatic Subregion.

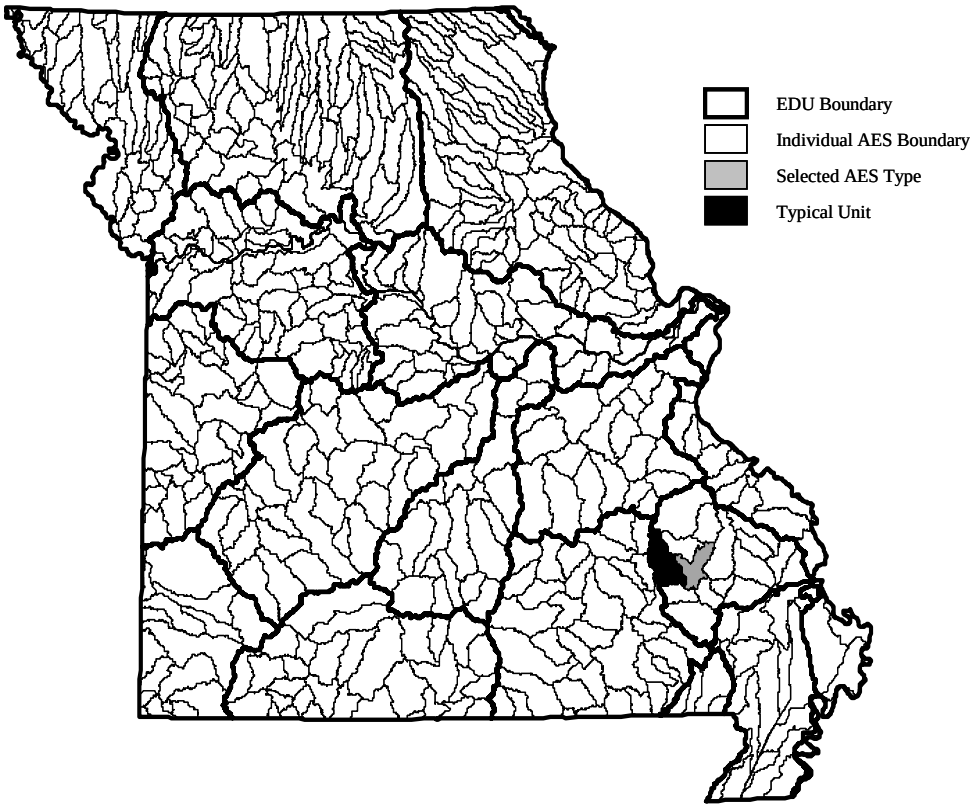
Ecological Drainage Units in Which This AES-Type Occurs:
Ozark/ Meramec EDU
Ozark/ Upper St. Francis/ Castor EDU
Ozark/ Black/ Current EDU

Description:
This AES-Type is located in one general cluster of the Ozark Aquatic Subregion. Local relief is typically high ranging from 50 to about 500 feet. This AES is characterized by resistant Precambrian igneous granite that is intruded by rhyolite and other volcanic rock. Exposed igneous knobs are connected by LaMott sandstone, Bonne Terre dolomite, and Potosi and Eminence cherty dolomites. Soils in this area are moderately deep and acidic with little calcium and magnesium. Surface soil textures consist of cherty, silty loams, and stony soils with moderate to slow infiltration rates. Soils that are found in lower positions are typically very deep with silty clay loam subsoils. This AES-Type has streams with sections that pass over resistant igneous rock forming shut-ins. These streams have little suspended sediment, but carry bed loads of gravel and sand. Springs, although present, are not as common as in other Ozark areas. Groundwater is not abundant due to the igneous rock. When groundwater is present it is often alkaline in nature. There are

34 headwater/creek springs with no main stem springs scattered throughout the 8 individual units comprising this AES-Type. The median spring count is 4. The mean stream gradient for the headwaters and creeks combined is a relatively high 17.6 meters per kilometer. Historic vegetation was varied and consisted of mixed-oak woodland and glades.

Typical unit: 455 – Little St. Francis River

AES-Type 20 (Big Creek of the St. Francis)



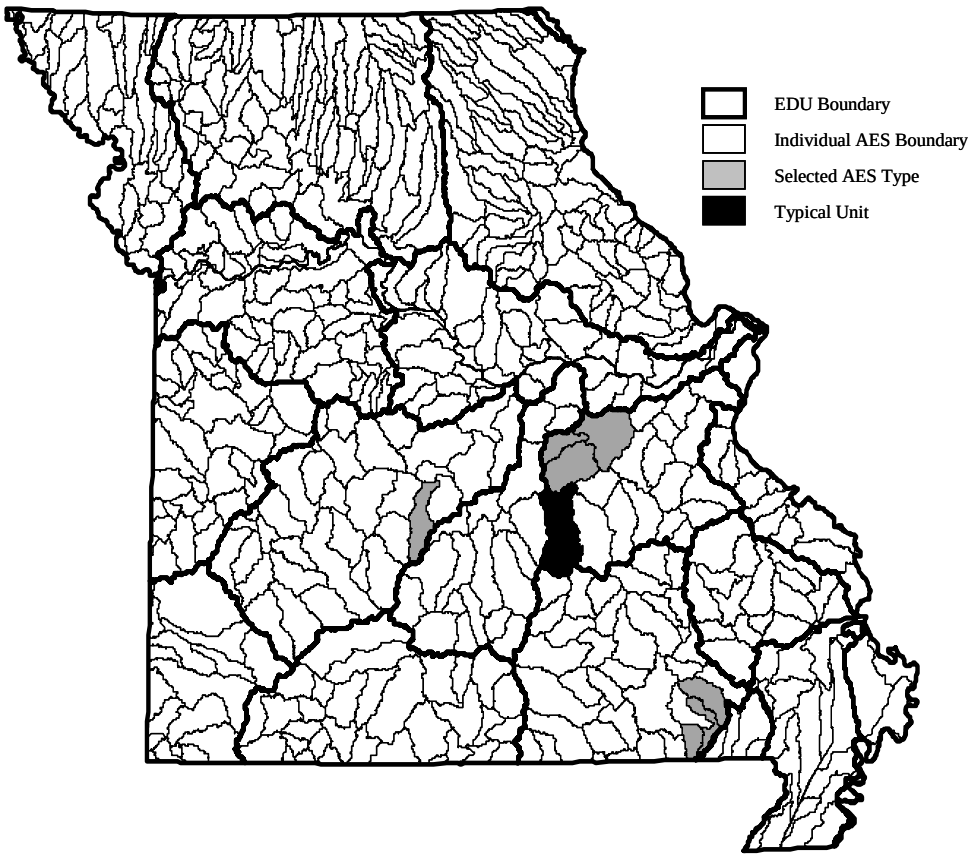
Geographic location:
Restricted to the Ozark Aquatic Subregion.

Ecological Drainage Units in Which This AES-Type Occurs:
Ozark/ Upper St. Francis/ Castor EDU

Description:
This AES-Type is located in the upper St. Francis drainage of the Ozark Aquatic Subregion. Local relief is concentrated between 100 and 500 feet, but can approach or exceed 700 feet in some locations. This AES contains some igneous rock, but receives most of its igneous influence from AES-Type 19 that is located directly upstream. AES-Type 20 is moderately dissected with hills and contains dolomite of the Eminence-Potosi Formation and some Cambrian Bonne Terre chert-free dolomite and shale. Ridges are broad and side slopes are steep. Soils are fairly deep and comprised of very cherty silty loams with variable infiltration rates. The streams here carry large bed loads of chert gravel. Coldwater is an important ecological feature of this Type. Springs are relatively abundant within this AES-Type. There are 64 headwater/creek springs and three main stem springs scattered throughout the two individual units comprising this AES-Type. The median spring count is 33.5. The combined headwater and creek mean stream gradient is relatively high at 17.7 meters per kilometer. The area was historically, and is still presently, vegetated with oak-pine woodlands and an occasional glade opening.

Typical unit: 453 – Big Creek a tributary to the St. Francis River

AES-Type 21 (Dry Fork of the Meramec)



Geographic location:
Restricted to the Ozark Aquatic Subregion.

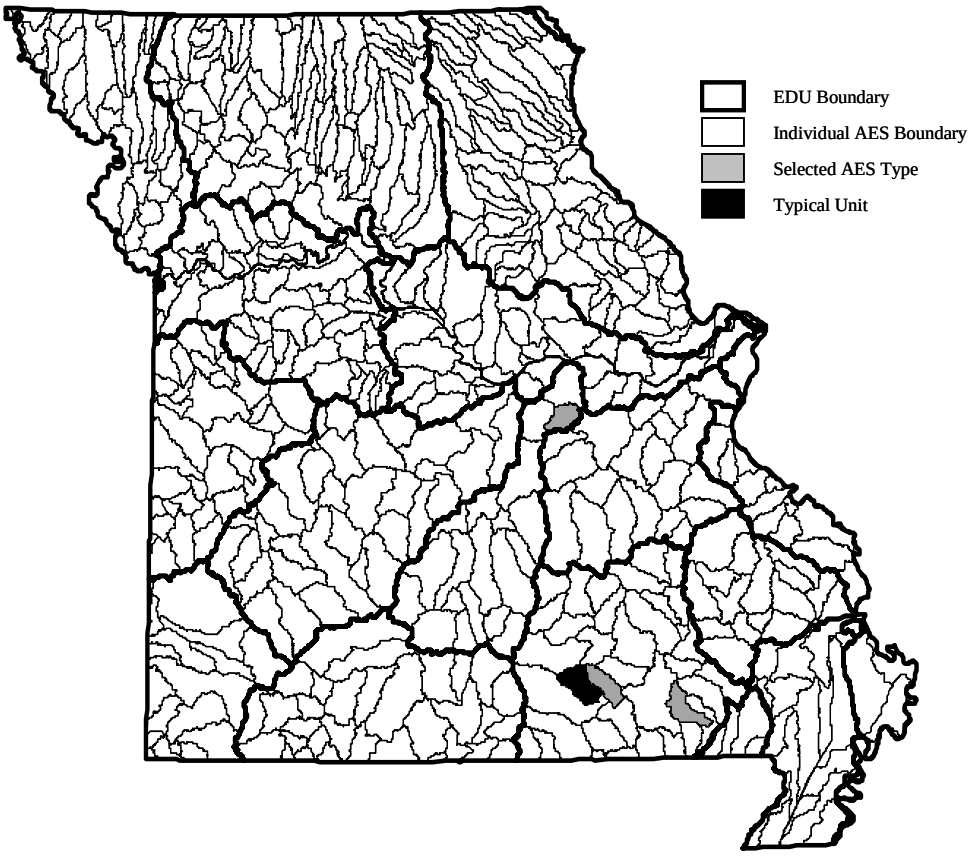
Ecological Drainage Units in Which This AES-Type Occurs:
Ozark/ Meramec EDU.
Ozark/ Black/ Current EDU.
Ozark/ Osage EDU.

Description:
This AES-Type consists of relatively small clusters of units scattered over parts of the central and eastern Ozarks. Local relief generally ranges from 50 to 200 feet. This area is a portion of the Ozarks that is not heavily dissected and consists of generally gentle slopes that steepen approaching major drainage divides. Most of this AES consists of carbonate bedrock over which sits residuum with lots of chert fragments. Sinkholes exist in some portions of this AES that are located in the more central part of the Ozarks. Soils formed from weathered Ordovician dolomite with some silty loess. Surface soil textures consist primarily of silt loams and cherty soils with infiltration rates ranging from very slow to moderate. Floodplains tend to be narrow and streams are often intermittent or ephemeral. Flows may be near zero in the drier summer months with streams reverting to strings of disconnected pools. Flash floods are not uncommon after heavy rain events. Spring densities are variable; although

overall they are not common with relatively small flows. There are 45 headwater/creek springs and six main stem springs scattered throughout the eight individual units comprising this type. This AES contains one known spring over 10 cfs. The median spring count is 3.5. The combined headwater and creek mean stream gradient is relatively average at 10.8 meters per kilometer. Historically, most of this AES was savannah or grassy and oak woodland.

Typical unit: 369 – Dry Fork of the Meramec

AES-Type 22 (Spring Creek of the Eleven Point)



Geographic location:
Restricted to the Ozark Aquatic Subregion.

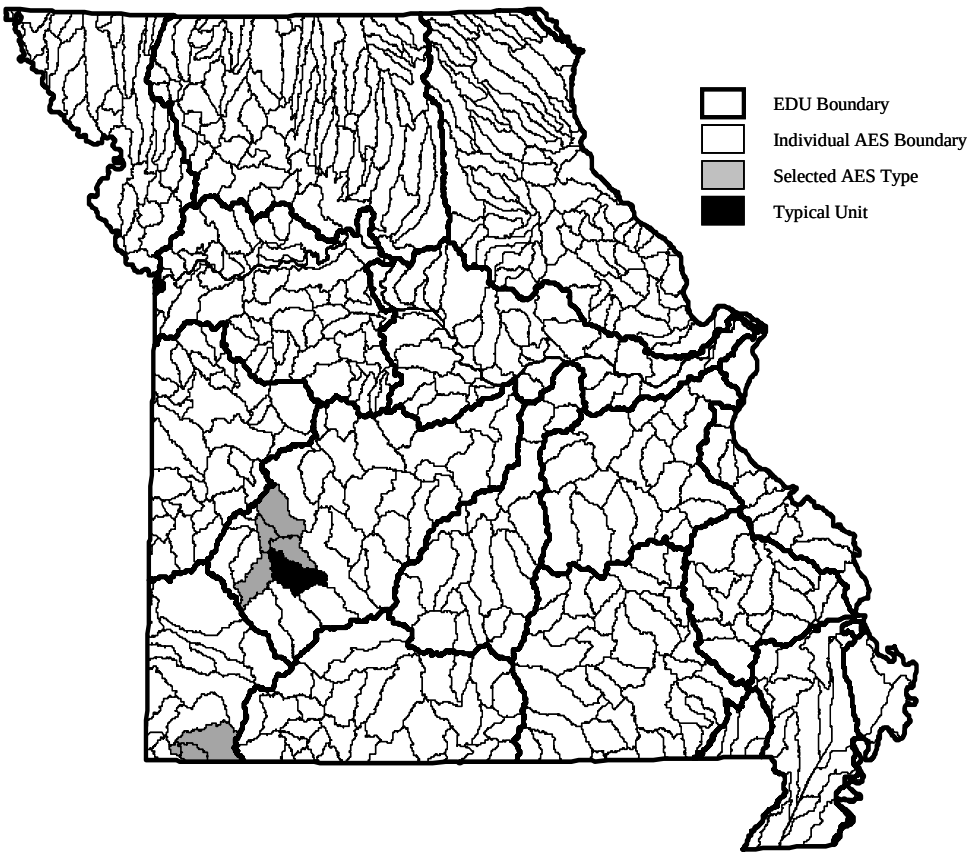
Ecological Drainage Units in Which This AES-Type Occurs:
Ozark/ Gasconade EDU
Ozark/ Current/ Black EDU

Description:
Despite the geographically disperse nature of this AES-Type, the individual units are similar with respect to a number of landscape variables. This AES-Type is characterized by dolomites and sandstones of the Gasconade and Roubidoux formations. The dolomite tends to be soluble creating karst conditions in these areas. Local relief is concentrated between 50 and 200 feet, but occasionally approaches 300 feet. Soils formed in residuum and often contain cherty rock fragments. Surface soil texture consists of silt loam and cherty soils with slow to moderate infiltration rates. Smaller streams are intermittent or ephemeral while the larger streams are perennial. Streams generally have steep gradients and carry sand and gravel bedloads with very little suspended sediment. Sand and gravel bars are common. Large rain events may produce flooding. Coldwater is an important ecological feature of this Type. Springs are common and groundwater is generally abundant and alkaline. There are 84 headwater/creek springs and five main stem springs scattered throughout the four individual units comprising this AES-Type. The

median spring count is 12. The combined headwater and creek mean stream gradient is 14.1 meters per kilometer.

Typical unit: 284 – Spring Creek of the Eleven Point River

AES-Type 23 (Middle Upper Little Sac)



Geographic location:
Restricted to the Ozark Aquatic Subregion.

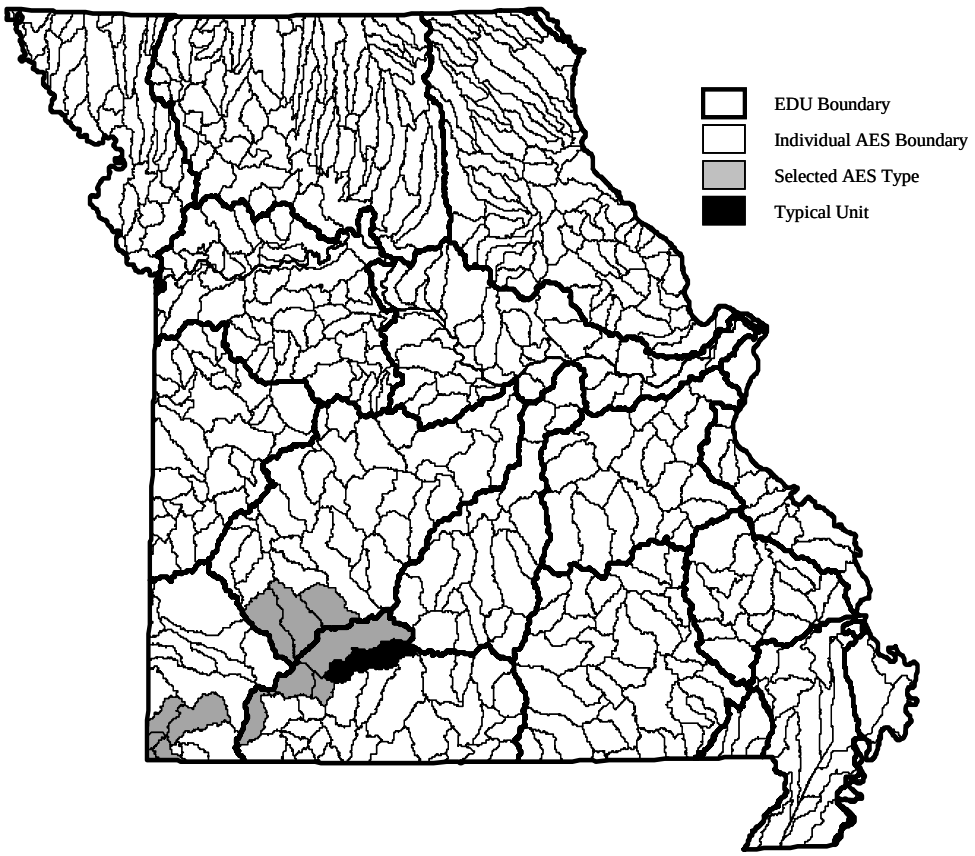
Ecological Drainage Units in Which This AES-Type Occurs:
Ozark/ Osage EDU
Ozark/ Neosho EDU

Description:
This AES-Type is located within the Ozarks in southwest Missouri. Local relief is variable, but typically ranges from 50 to over 200 feet. This area consists of Mississippian cherty limestone geologic formations with some karst features. Some of the deeper stream valleys cut down into the Ordovician Jefferson City – Cotter Formation. Soils in this AES-Type were formed in weathered cherty limestone and are deep. Surface soil texture consists of cherty soils and silt loams with moderate to slow infiltration rates. Streams have narrow floodplains and carry bedloads of gravel and sand that form bars. Stream flows are highest at the end of winter and into spring and diminish the rest of the year. Flash floods can occur after large rain events. Springs are common and can be quite large contributing greatly to stream base flows. Groundwater is relatively abundant and of good quality. There are 43 headwater/creek springs with no main stem springs scattered throughout the eight individual units comprising this AES-Type. The median spring count is 3.5. The combined headwater and creek mean stream gradient is relatively high at 12.9

meters per kilometer. Historically the vegetation within this AES-Type consisted of prairie on the flatter portions with oak savanna and woodlands on the more rugged sections.

Typical unit: 412 – Middle Upper Little Sac River

AES-Type 24 (Finley Creek)



Geographic location:
Restricted to the Ozark Aquatic Subregion.

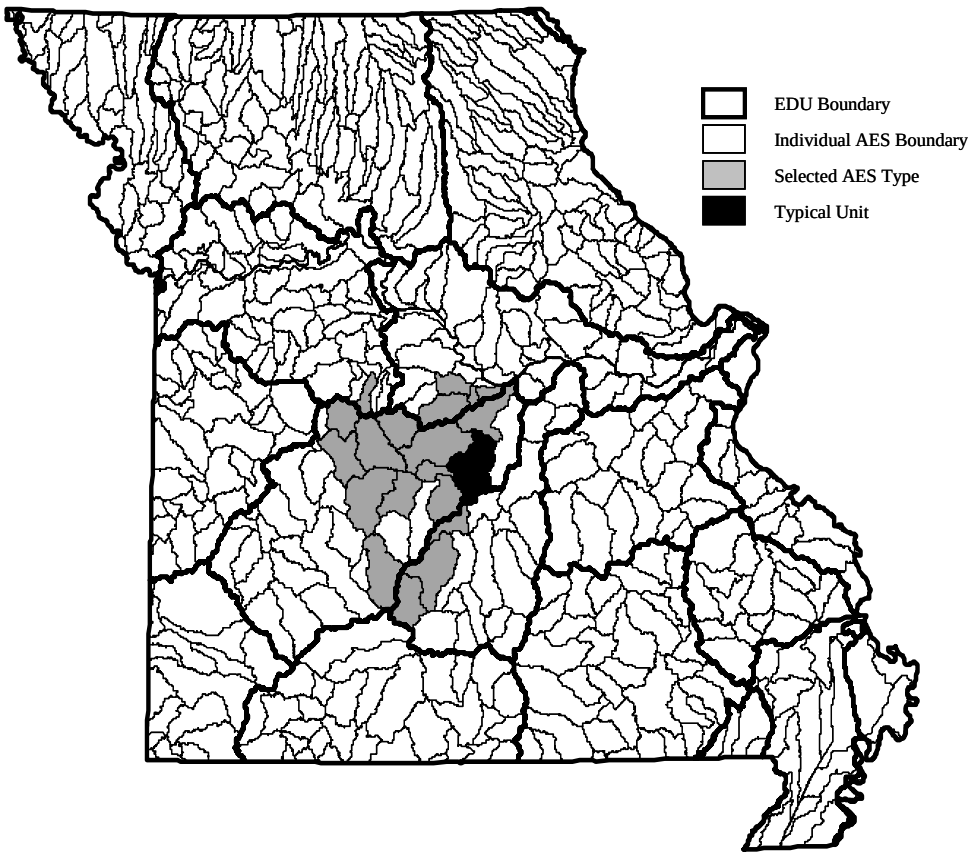
Ecological Drainage Units in Which This AES-Type Occurs:
Ozark/ Osage EDU
Ozark/ White EDU
Ozark/ Neosho EDU

Description:
This AES-Type is located in the Ozarks of southwest Missouri. Local relief ranges from nearly zero to slightly over 200 feet. The geology here consists of Mississippian period cherty limestones with significant karst features including sinkholes, caves and springs. Some of the highest densities of sinkholes in the state of Missouri can be found within this AES-Type. Minor amounts of dolomite and sandstone are also present. The deep soils were formed in weathered cherty limestone and often have loess as the surface material. Surface soil textures consist of cherty and silt loam soils with moderate to slow infiltration rates. Stream discharge is highest at the end of winter and early spring and subsequently diminishes throughout summer and into fall. Heavy rain events can produce flash flooding. Streams carry bed loads consisting of sand and chert gravel, but carry very little suspended sediment. Some of the highest densities of losing streams in the state are found in this Type, especially in the James River and Indian Creek drainages. Springs are common and

can be quite large contributing significantly to stream base flows. Groundwater is abundant and of good quality. Coldwater is an important ecological feature of this Type. There are 489 headwater/creek springs and one main stem spring scattered throughout the 14 individual units comprising this Type. This AES-Type contains one spring over 10 cfs. The median spring count is 29.5. The combined headwater and creek mean stream gradient is 13.3 meters per kilometer. The historic vegetation consisted primarily of prairie, but timber was located along the stream valleys.

Typical unit: 464 – Finley Creek

AES-Type 25 (Tavern Creek)



Geographic location:
Restricted primarily to the Ozark Aquatic Subregion, but is found in one EDU of the Central Plains.

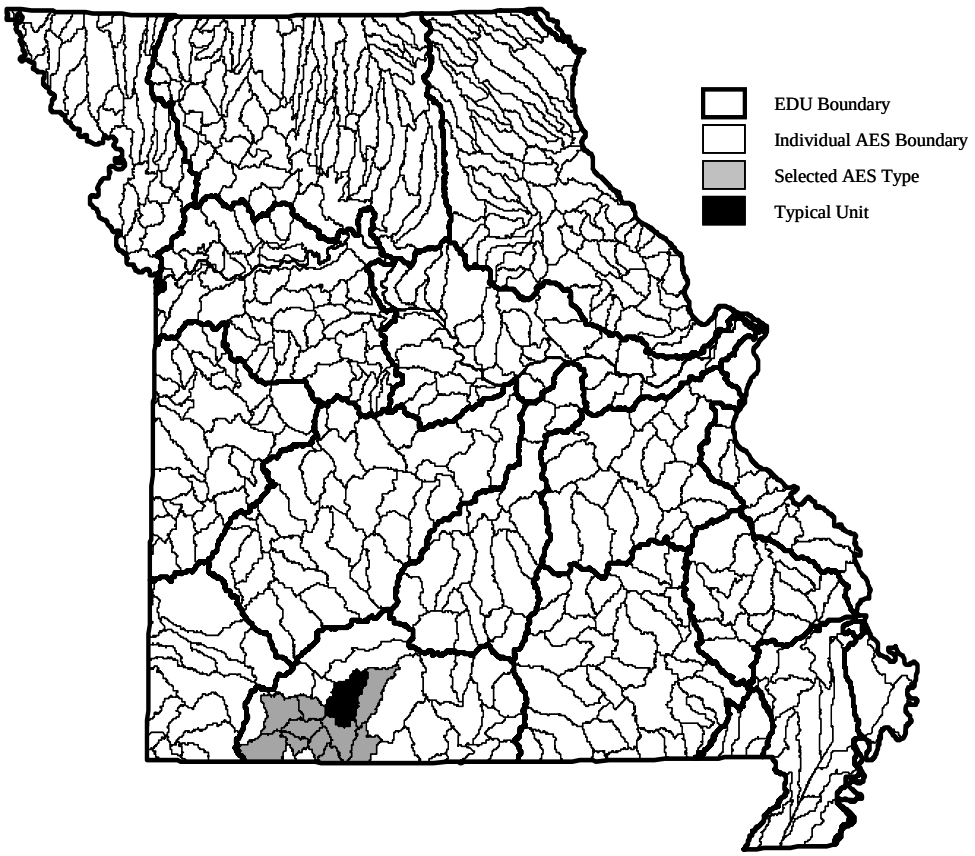
Ecological Drainage Units in Which This AES-Type Occurs:
Central Plains/ Blackwater/ Lamine EDU
Ozark/ Moreau/ Loutre EDU
Ozark/ Osage EDU
Ozark/ Gasconade EDU

Description:
This AES-Type is concentrated in the eastern portion of the Ozark/Osage EDU and the margins of adjacent EDU's. Local relief is generally less than 200 feet, but occasionally surpasses that. This AES-Type consists of cherty dolomites and sandstones of the Gasconade and Roubidoux formations of the Ordovician. Karst features are present and springs are very numerous and often quite large. The land is heavily dissected and consists of steep slopes with rock outcropings. Soils are variable and are a product of their parent materials. Surface soil textures consist of cherty or silt loam soils with moderate to slow infiltration rates. Streams of moderate to steep gradient carry bedloads of gravel and sand that form bars of these same materials. Stream flow is highest in the spring. Stream base flows are supported by springs that consist of good quality albeit alkaline water. There are 177

headwater/creek springs and 14 main stem springs scattered throughout the 20 individual units comprising this AES-Type. This AES-Type contains one spring over 10 cfs. The median spring count is 6.5. The combined headwater and creek mean stream gradient is relatively high at 14.6 meters per kilometer. Historic vegetation was varied.

Typical unit: 430 – Tavern Creek

AES-Type 26 (Bull Creek)



Geographic location:
Restricted to the southwestern portion of the Ozark Aquatic Subregion.

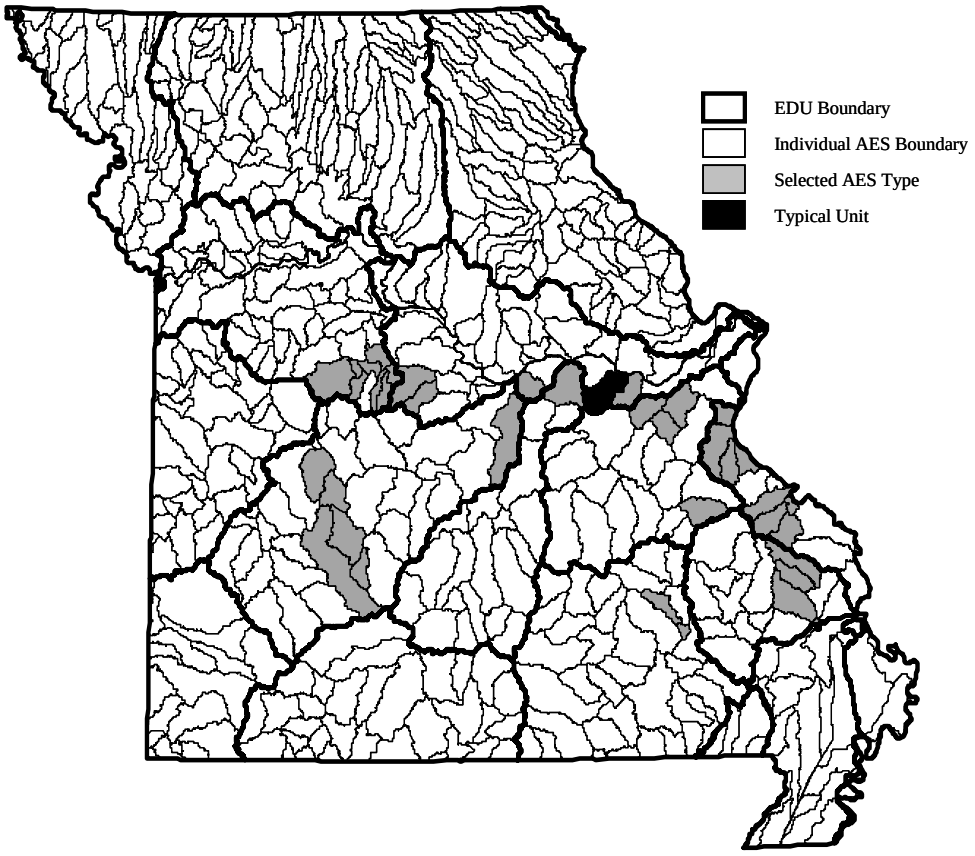
Ecological Drainage Units in Which This AES-Type Occurs:
Ozark/ White EDU

Description:
This AES-Type is completely contained within the Ozark/White EDU. Local relief ranges from 50 to nearly 500 feet. This AES-Type consists of cherty, shaley dolomites of the Ordovician Jefferson City Cotter Formation with karst features and numerous chert fragments. The land surface is thoroughly dissected by drainage networks. Soils were formed from weathered Mississippian and Ordovician limestone and dolomite. Surface soil textures are typically cherty, silty loam, or stony and exhibit slow to moderate infiltration rates. Streams have relatively narrow floodplains and very steep gradients while carrying bedloads of sand and gravel which accumulate into bars. Flows are highest in the late winter and early spring. Flash floods occur after periods of intense rainfall. There are a large number of springs that contribute a significant portion of water to stream base flows throughout much of the year. Headwater streams are often dry, as a result of karst, and lose much of their water to the ground. According the Missouri Department of Conservation's White River Watershed Inventory and Assessment plan, Bull Creek's substrate consists of gravel, cobble, pebble, boulder, and bedrock in relatively equal

proportions. The combined headwater and creek mean stream gradient is very high at 22.0 meters per kilometer and is the highest of any AES-Type in Missouri. Historical vegetation consisted largely of glade and woodland complexes.

Typical unit: 475 – Bull Creek

AES-Type 27 (Boeuf Creek)



Geographic location:
Largely follows the rim of the central Ozark dome.

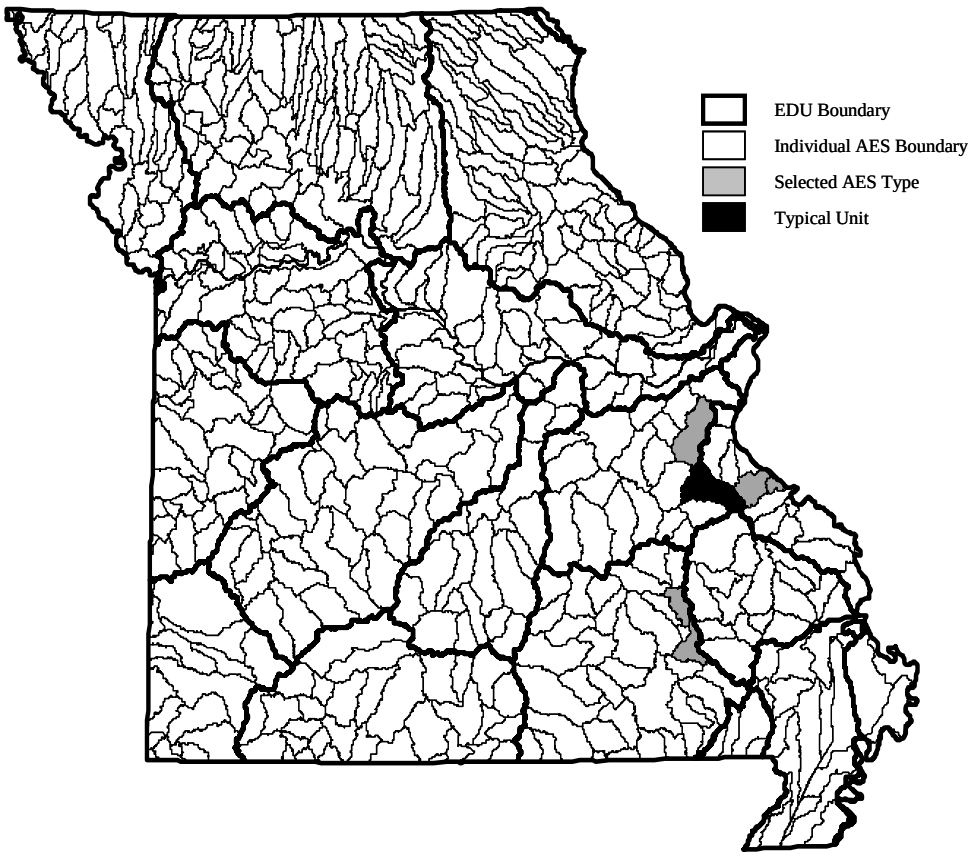
Ecological Drainage Units in Which This AES-Type Occurs:
Central Plains/Blackwater/Lamine EDU
Ozark/ Moreau/ Loutre EDU
Ozark/ Gasconade EDU
Ozark/ Meramec EDU
Ozark/ Apple/ Joachim EDU
Ozark/ Upper St. Francis/ Castor EDU
Ozark/ Black/ Current EDU
Ozark/ Osage EDU

Description:
This AES-Type forms a rough belt around much of the core Ozarks. Local relief is variable and is concentrated between 50 and 200 feet, but does frequently exceed this range. Bedrock geology is dominated by cherty dolomites of the Ordovician Jefferson City-Cotter Formation, although sandstone and limestone are also occasionally present. This bedrock geology is often exposed at the surface. There are some sinkholes, but they are not particularly common in most areas. Adjacent to the Missouri River are thick silty loess deposits that tend to thin with increasing distance from the river. Soils are variable according to both parent material and their

position in the landscape. Surface soil textures consist of silty loams or occasionally cherty soils and tend to have slow to moderate infiltration rates. Streams draining to the Great Rivers in the AES-Type consist of headwaters and creeks and the lower ends of larger rivers. In these instances the stream valleys are often deeply entrenched with relatively steep gradients. Stream flow is usually highest in the spring and lowest in the fall. Flash floods may occur after heavy rain events. Spring influence is variable and is not as characteristic as in some of the other Ozark units. There are 113 headwater/creek springs and eight main stem springs scattered throughout the 38 individual units comprising this AES-Type. The median spring count is 2. The combined headwater and creek mean stream gradient is 12.8 meters per kilometer. Historic vegetation consisted of oak savanna, woodlands and smaller amounts of prairie and glades.

Typical unit: 399 – Boeuf Creek

AES-Type 28 (Middle Upper Big River)



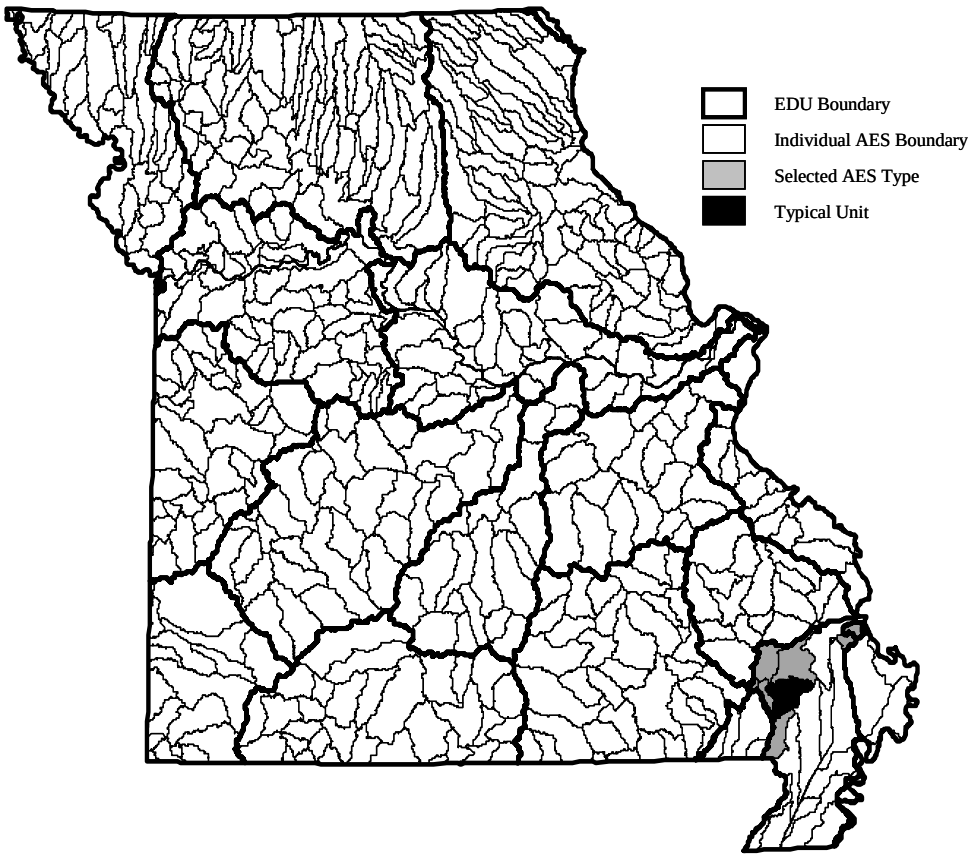
Geographic location:
Restricted to the Ozark Aquatic Subregion.

Ecological Drainage Units in Which This AES-Type Occurs:
Ozark/ Meramec EDU
Ozark/ Apple/ Joachim EDU
Ozark/ Black/ Current EDU

Description:
This AES-Type is located in the east-central Ozark Aquatic Subregion of Missouri. Local relief is concentrated between 50 and 500 feet. Surface soil textures vary but consist predominantly of silt loams with some cherty and stony soils. These soils exhibit slow to moderate infiltration rates. Bedrock geology consists mainly of dolomite with varying amounts of limestone and sandstone. Coldwater is an important ecological feature of this Type. There are 85 headwater/creek springs and six main stem springs scattered throughout the six individual units comprising this AES-Type. The median spring count is 11.5.

Typical unit: 362 – Middle Upper Big River

AES-Type 29 (Crowley's Ridge)



Geographic location:
Restricted to the Mississippi Alluvial Basin Aquatic Subregion and a small unit in the Ozarks.

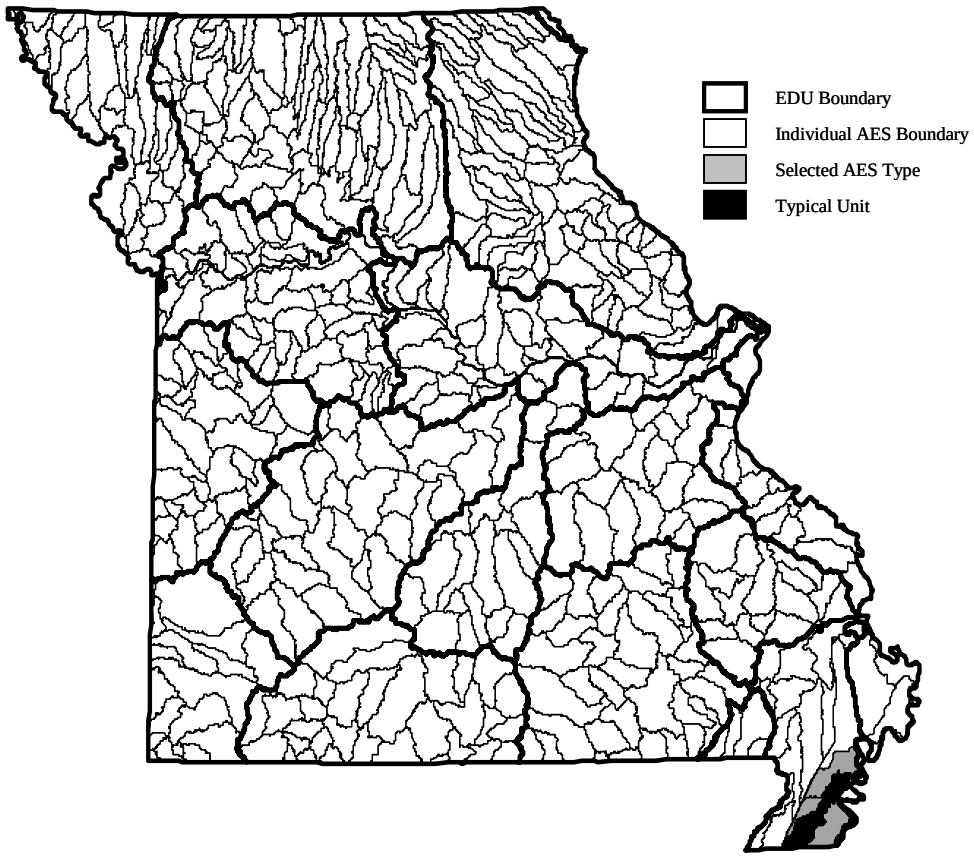
Ecological Drainage Units in Which This AES-Type Occurs:
Mississippi Alluvial Basin/ St. Francis/ Little EDU.
Ozark/ Upper St. Francis/ Castor EDU.

Description:
This AES-Type is located east of the St. Francis River and encompasses most of Crowley's Ridge and the Benton Hills. Local relief ranges from 50 to 200 feet in Crowley's Ridge and the Benton Hills, but there is almost no relief in the lowlands off the Ozark uplands and Crowley's Ridge. The bedrock core of Crowley's Ridge consists of Ordovician dolomite and limestone on the northwest with Cretaceous and Tertiary sandstone and clays to the east. The bedrock is overlain by Quaternary alluvial gravel and sands which in turn is overlain by loess. Crowley's Ridge soils are fairly deep and formed in loess under forest conditions with a silt loam surface layer. In the lowland portions of this AES-Type the soils were formed in alluvial deposits, whereas soils on the ridges are underlain by sandstone and minor dolomite components. Areas adjacent to Crowley's Ridge in this AES-Type are very flat low relief plains composed of silts and sands sitting above deep bedrock which in turn are capped by alluvium. Generally for this AES-Type soils are deep and have surface

textures consisting of silty loams that have very slow to moderate infiltration rates. Stream valleys occasionally cut through the loess and expose the underlying materials. Crowley's Ridge consists mainly of intermittent or ephemeral headwater streams that drain down to the lower alluvial plains. The exception to this scenario is the Castor River that cuts through Crowley's Ridge. Natural streams are/were very meandering. There are six headwater/creek springs and zero main stem springs known to exist within the eight individual units comprising this type. The median spring count is 0. The combined headwater and creek mean stream gradient is 6.1 meters per kilometer. Historically a large portion of the lowland area was inundated permanently or at least seasonally. The historic vegetation consisted of mixed hardwood forest on Crowley's Ridge with bottomland forest, swamps, marshes and sand prairies on the lowland areas.

Typical unit: 597 – Crowley's Ridge

AES-Type 30 (City of Hayti)



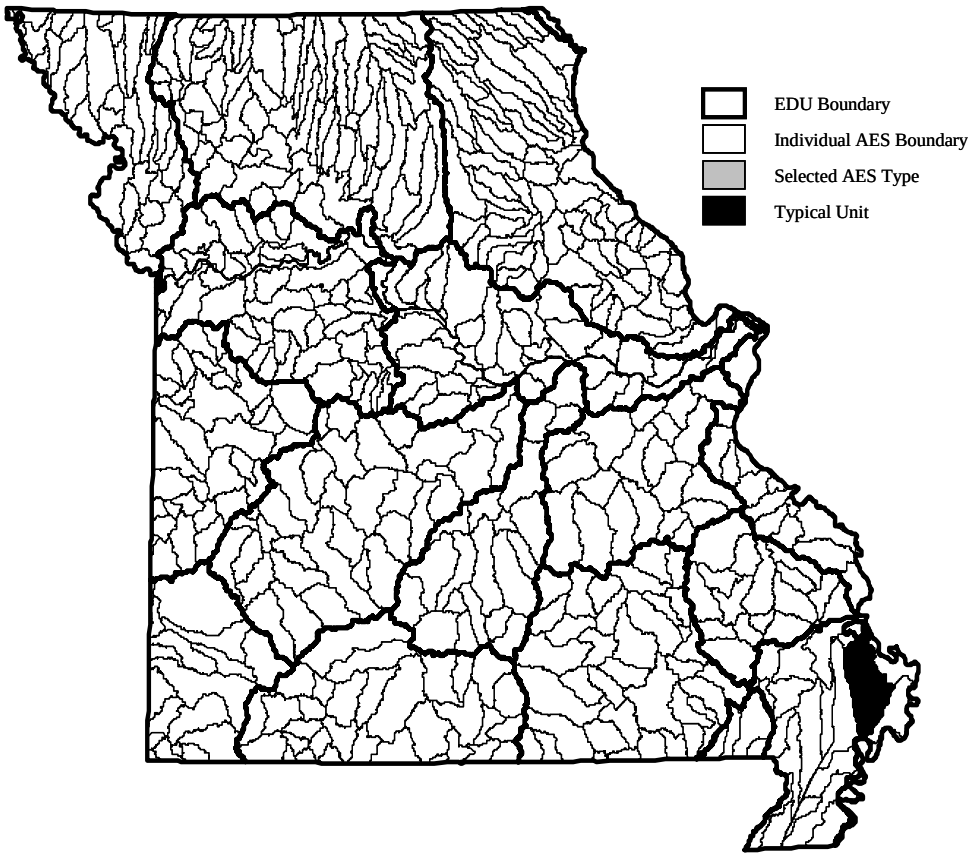
Geographic location:
Restricted to the Mississippi Alluvial Basin Aquatic Subregion.

Ecological Drainage Units in Which This AES-Type Occurs:
Mississippi Alluvial Basin/ St. Francis/ Little EDU.

Description:
This AES-Type is located in the southeast Mississippi Alluvial Basin. The area is extremely flat with the slope of the land ranging only between one and 1.5 feet per mile. This area is the historic and present-day alluvial plain of the Mississippi River and consists of thick alluvium with clays in the lower areas and sands in higher areas. Surface soil textures consist of silty clay, silty clay loam, and silty loam with very slow and slow infiltration rates. These soils formed in the alluvial deposits characteristic of much of the Mississippi Alluvial Basin. Natural stream channels here were intensely meandering. Groundwater is abundant. There are no known springs within the four individual units comprising this type. The combined headwater and creek mean stream gradient is 0.6 meters per kilometer. Historically the area consisted of wet bottom-land forest, swamps, and marshes.

Typical unit: 516 – City of Hayti

AES-Type 31 (St. Johns Diversion Ditch)



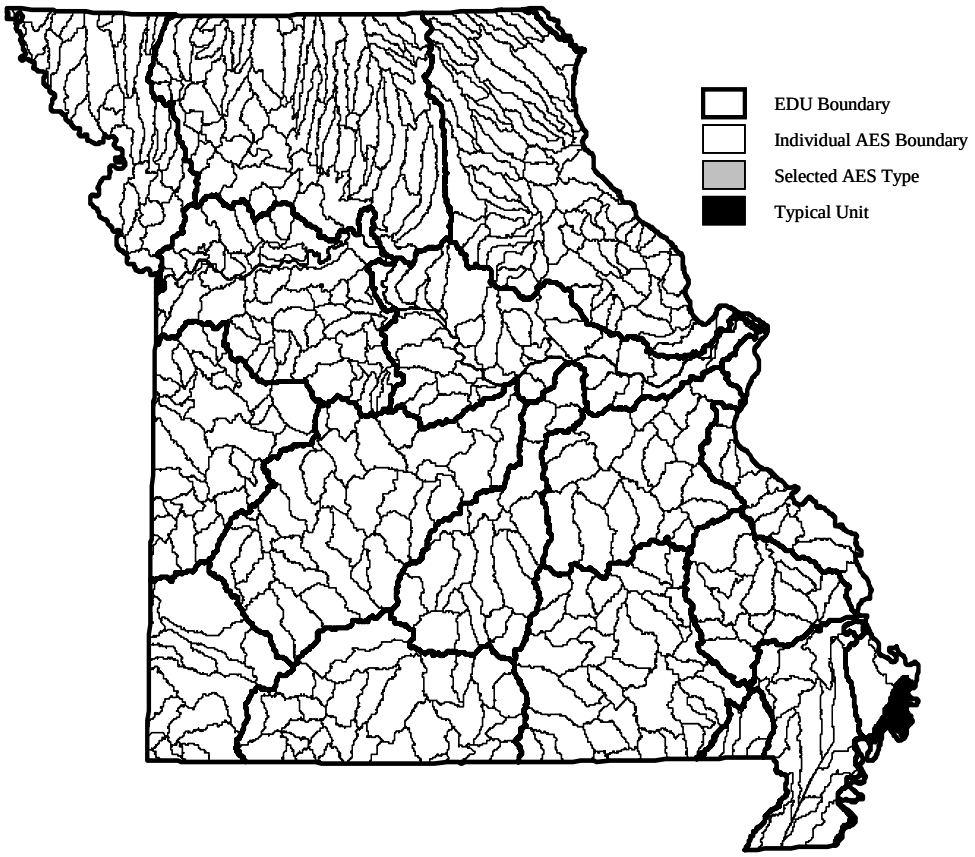
Geographic location:
Restricted to the Mississippi Alluvial Basin Aquatic Subregion.

Ecological Drainage Units in Which This AES-Type Occurs:
Mississippi Alluvial Basin/ St. Johns Bayou EDU.

Description:
This AES-Type occupies an area drained by the St. Johns Diversion Ditch in the northeast portion of the Mississippi Alluvial Basin. The northern edge of this AES-Type abuts up to the Benton Hills. The slope of the land is only about one to 1.5 feet per mile. Local relief is generally less than ten feet. The area is comprised of thick alluvium with clays in the lower areas and sands on the slightly higher ridges or natural levees. Soils are deep and have surface soil textures consisting of sandy, loamy, and clayey soils. These soils exhibit varied infiltration rates from high to very slow. The soils formed in alluvial deposits. A few headwater streams begin in the Benton Hills. Groundwater is abundant. There are no known springs within the one individual unit comprising this type. The combined headwater and creek mean stream gradient is 0.9 meters per kilometer.

Typical unit: 513 – St. Johns Diversion Ditch

AES-Type 32 (Wilkerson Ditch)



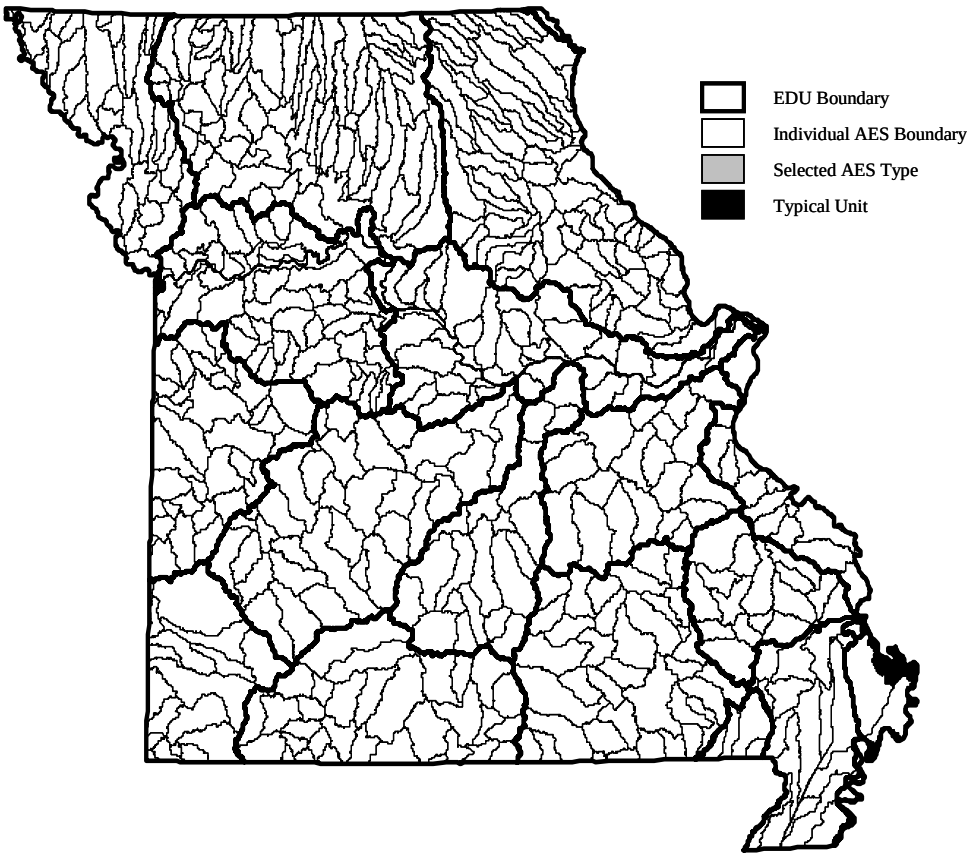
Geographic location:
Restricted to the Mississippi Alluvial Basin Aquatic Subregion.

Ecological Drainage Units in Which This AES-Type Occurs:
Mississippi Alluvial Basin/ St. Johns Bayou EDU.

Description:
This AES-Type is located in an area drained by present day Wilkerson Ditch in the east central portion of the Mississippi Alluvial Basin. Local relief is generally less than 10 feet. The area is composed of thick alluvium with clays in the lower areas and sands in the slightly higher locations. The general slope of the land is one to 1.5 feet per mile. The soils are deep and formed in alluvial deposits. Surface soil texture consists of silty clays and sandy soils. These soils exhibit very slow, slow and even some moderate infiltration rates. Groundwater is abundant. There are no known springs within the single unit making up this AES-Type. The combined headwater and creek mean stream gradient is 0.4 meters per kilometer.

Typical unit: 514 – Wilkerson Ditch

AES-Type 33 (City of Charleston)



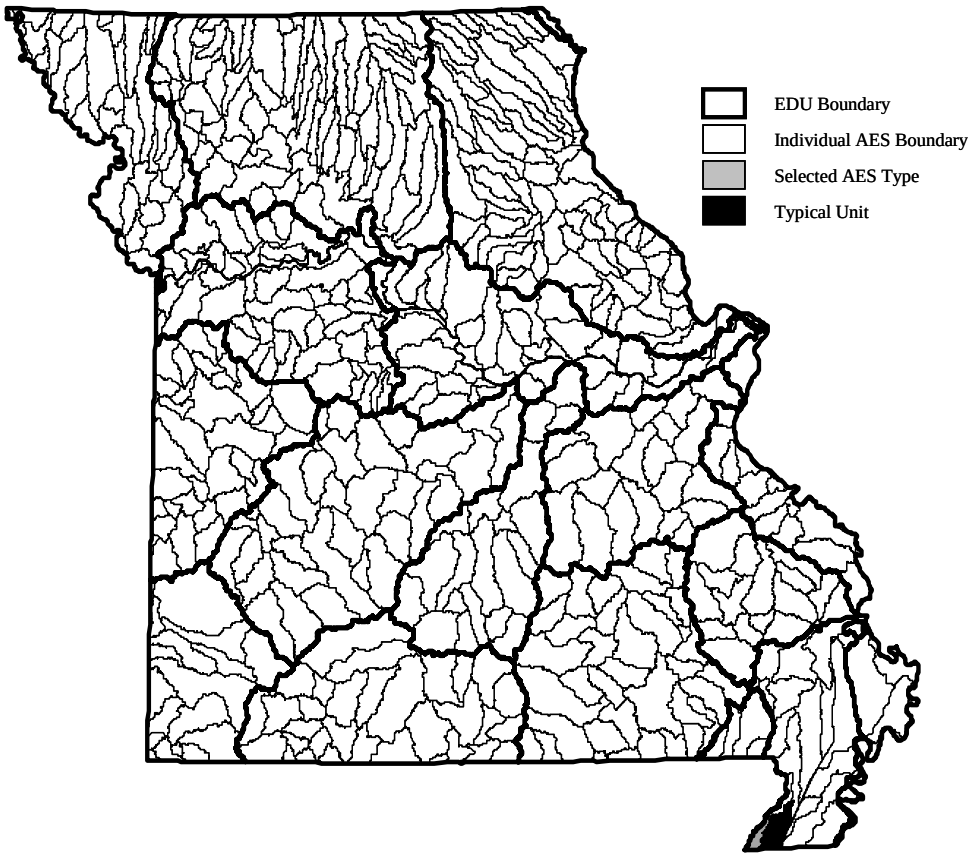
Geographic location:
Restricted to the Mississippi Alluvial Basin Aquatic Subregion.

Ecological Drainage Units in Which This AES-Type Occurs:
Mississippi Alluvial Basin/ St. Johns Bayou EDU.

Description:
This AES-Type consists of a narrow belt of very small lateral tributaries draining to the Mississippi River within the Mississippi Alluvial Basin Aquatic Subregion. The northwest edge of this unit contains a very small portion of the Benton Hills. Local relief is generally less than 10 feet. The area generally consists of thick alluvium with clays in the lower areas and sands in the higher. Surface soil textures consist primarily of silty clays with minor amounts of silty loams and sandy soils. These soils exhibit slow and very slow infiltration rates and were formed in alluvial sediments. Groundwater is abundant. There are no known springs within the two individual units comprising this AES-Type. The combined headwater and creek mean stream gradient is 1.2 meters per kilometer.

Typical unit: 524 – City of Charleston

AES-Type 34 (City of Senath)



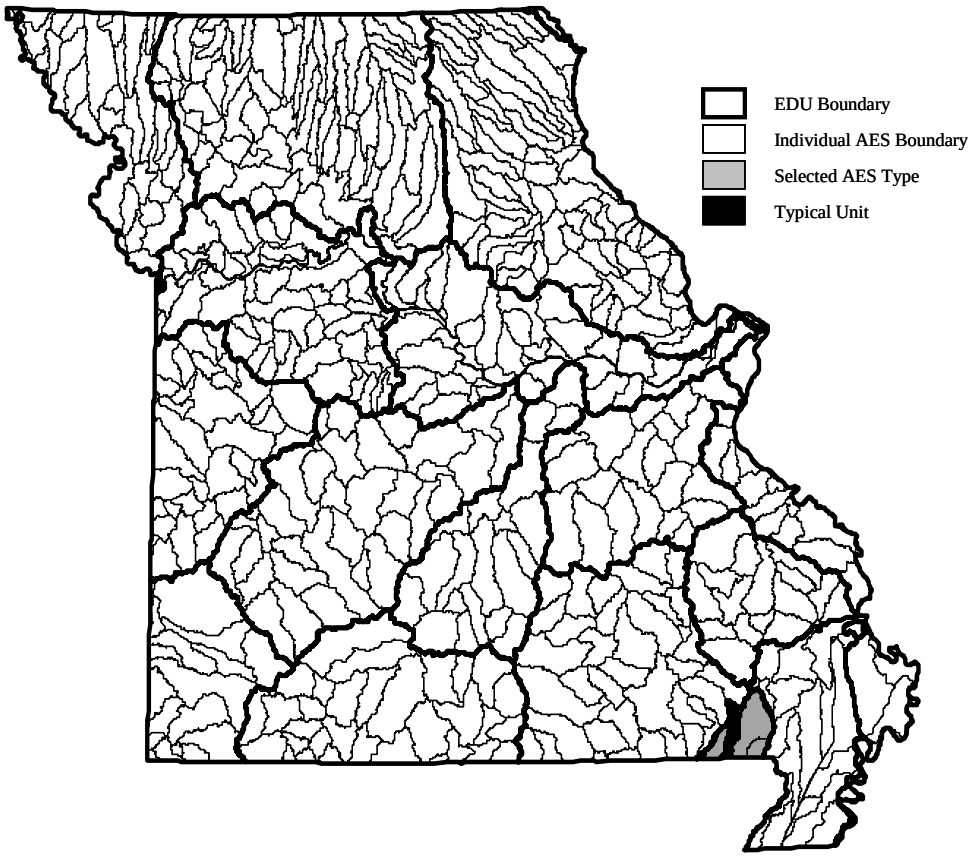
Geographic location:
Restricted to the Mississippi Alluvial Basin Aquatic Subregion.

Ecological Drainage Units in Which This AES-Type Occurs:
Mississippi Alluvial Basin/ St. Francis/ Little EDU.

Description:
This AES-Type occupies an area in extreme southern Missouri between the St. Francis and Little Rivers. Local relief is generally less than 10 feet. This area is part of an old sandy and loamy alluvial terrace. Surface soils consist of silty loams and sandy soils with very slow or moderate infiltration rates. These soils formed in alluvial sediments. Soil distribution patterns are related to the historic stream networks, natural levees, back swamps, and terraces that were formed be the ancient Mississippi and Ohio Rivers. Bedrock is very deep. There are no known springs within the two units comprising this AES-Type. The combined headwater and creek mean stream gradient is 0.3 meters per kilometer and is the lowest of any in the state of Missouri.

Typical unit: 520 – City of Senath

AES-Type 35 (Cane Creek)



Geographic location:
Restricted to the Mississippi Alluvial Basin Aquatic Subregion.

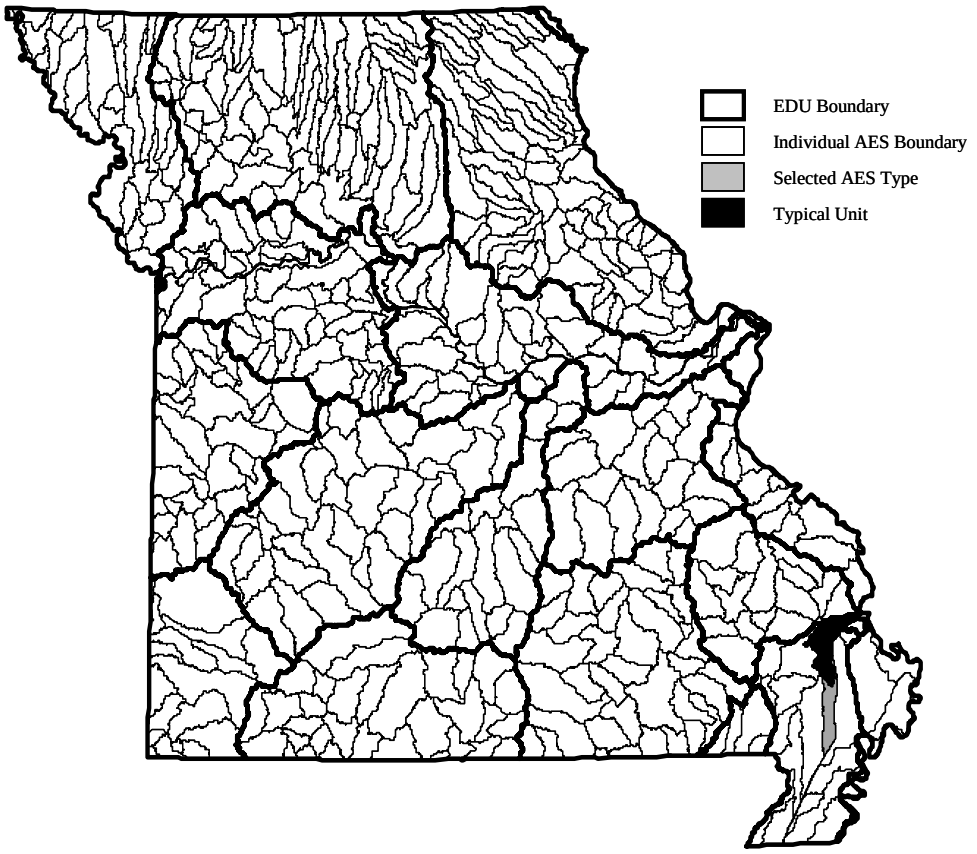
Ecological Drainage Units in Which This AES-Type Occurs:
Mississippi Alluvial Basin/ Black/ Cache EDU.

Description:
This AES-Type occupies an area in the Mississippi Alluvial Basin along the Black River and Cane Creek south of the Ozarks. Local relief is generally less than 10 feet, but a few areas may approach 20 feet. The soils in this AES-Type are deep and formed in alluvial deposits above bedrock that is very deep. Thousands of years ago this AES-Type was part of the Mississippi River alluvial plain when that river flowed along the base of the Ozarks. Today, streams including Cane Creek and the Black River flow from the Ozarks and deposit their coarser alluvial materials on top of the alluvium deposited in the past by the Mississippi River. The same streams that begin in the Ozarks take on a new character with drastically reduced gradients and begin to pick up finer silts and clays. Surface soil textures consist of silty loams and sandy soils with very slow infiltration rates. These soils formed in alluvium or, in the upper portions, are underlain by sandstone. Natural channels are very meandering and historically flowed through bottomland forest, swamps, marshes, and sand prairies. A good portion of this AES-Type would have been seasonally or permanently inundated historically. There is only one headwater/creek spring within the four

individual units comprising this AES-Type. The median spring count is 0. The combined headwater and creek mean stream gradient is 1.2 meters per kilometer.

Typical unit: 504 - Cane Creek

AES-Type 36 (City of Chaffee)



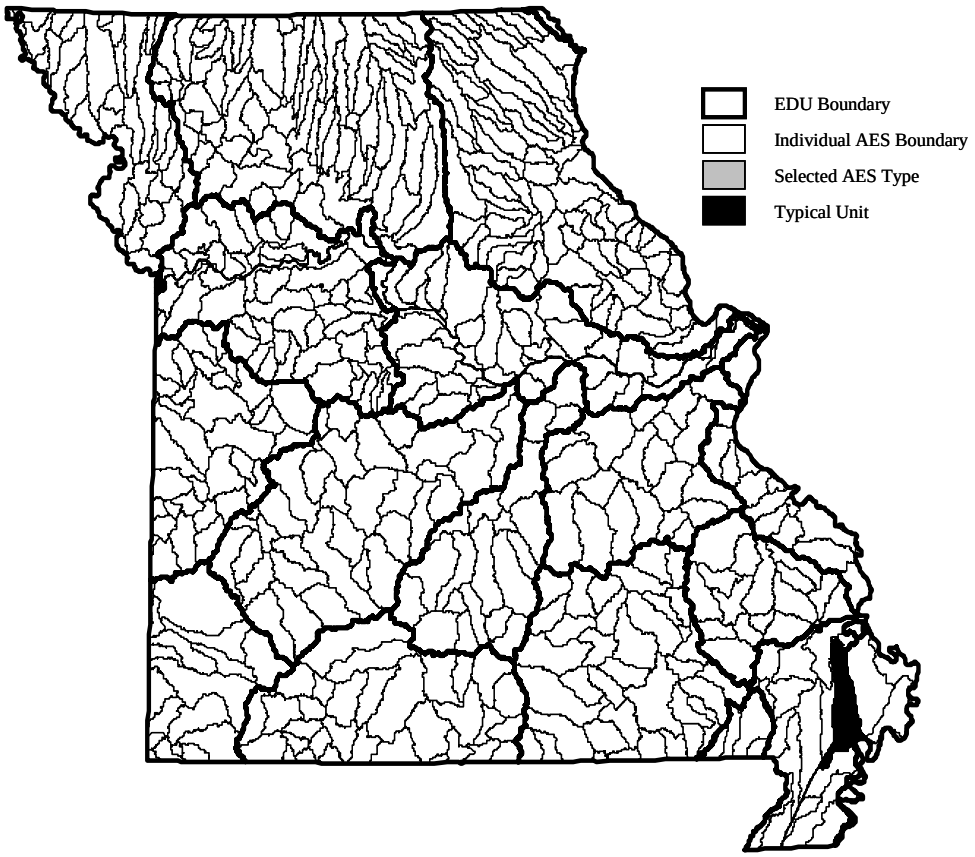
Geographic location:
Restricted to the Mississippi Alluvial Basin Aquatic Subregion.

Ecological Drainage Units in Which This AES-Type Occurs:
Mississippi Alluvial Basin/ St. Francis/ Little EDU.

Description:
This AES-Type consists of a north-south trending unit located in the central part of the Mississippi Alluvial Basin. This Type contains a very small part of Crowley's Ridge on the north and west edges with a few headwater tributaries commencing on the ridges. Local relief is generally less than 10 feet. The area consists of thick alluvium with clays in the lower areas and sands in the higher terraces and ridges. Soils are deep and were formed in alluvium from the Mississippi and Ohio Rivers. The silty clay and silty loam surface textured soils exhibit very slow to moderate infiltration rates. Groundwater is abundant. There are no known springs within the two individual units comprising this AES-Type. The median spring count is 0. The combined headwater and creek mean stream gradient is 1.7 meters per kilometer. Much of this AES-Type was historically swampland, sloughs and bottomland forest.

Typical unit: 511 – City of Chaffee

AES-Type 37 (Little River)



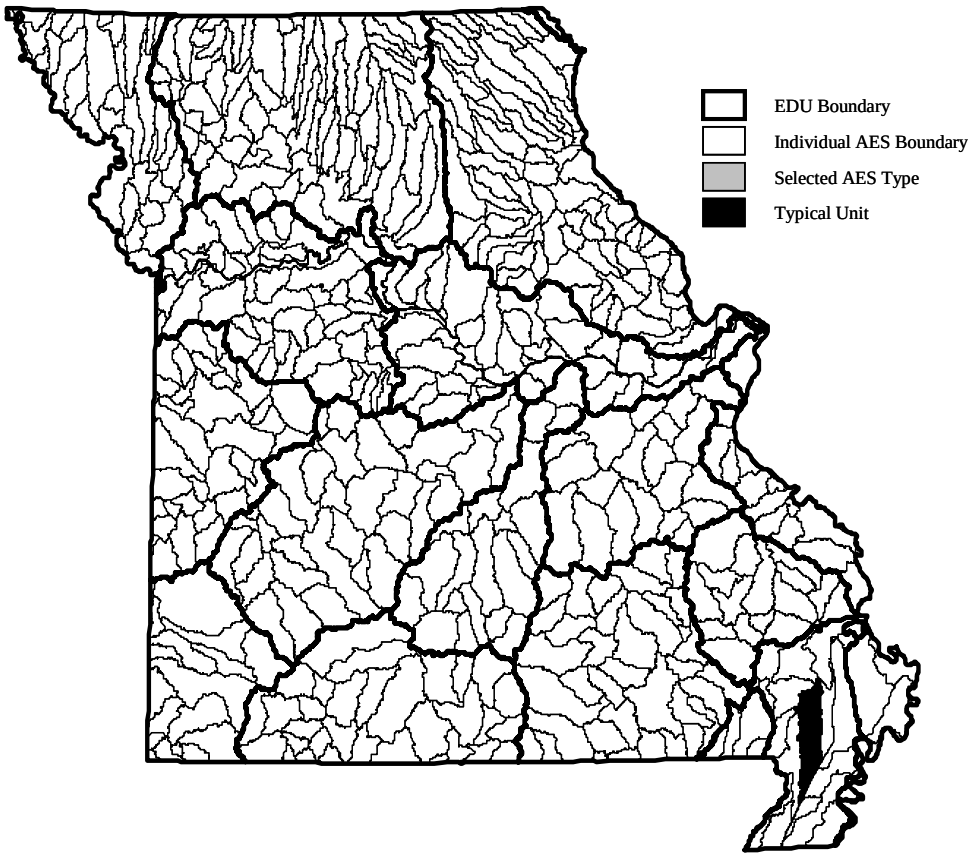
Geographic location:
Restricted to the Mississippi Alluvial Basin Aquatic Subregion.

Ecological Drainage Units in Which This AES-Type Occurs:
Mississippi Alluvial Basin/ St. Francis/ Little EDU.

Description:
This AES-Type occupies an area in the Mississippi Alluvial Basin along the northeast boundary of the Mississippi Alluvial Basin/ St. Francis/ Little EDU. The extreme northeast edge of this AES-Type contains a very small portion of the Benton Hills. A handful of headwater tributaries begin in the hills. Local relief is generally less than 10 feet. The plains areas consist of thick alluvium with clays in the lower alluvial plains and sands on the terraces and ridges. Soils formed in alluvial deposits. Surface soil textures are varied and range from sandy, to clayey, and even loamy. Equally varied are the soil infiltration rates that range from very slow to high. As with most of the Mississippi Alluvial Basin groundwater is abundant. There is only one known headwater/creek spring within the one unit comprising this AES-Type. The median spring count is 1. The combined headwater and creek relative stream gradient is 1.0 meters per kilometer.

Typical unit: 512 - Little River

AES-Type 38 (City of Gideon)



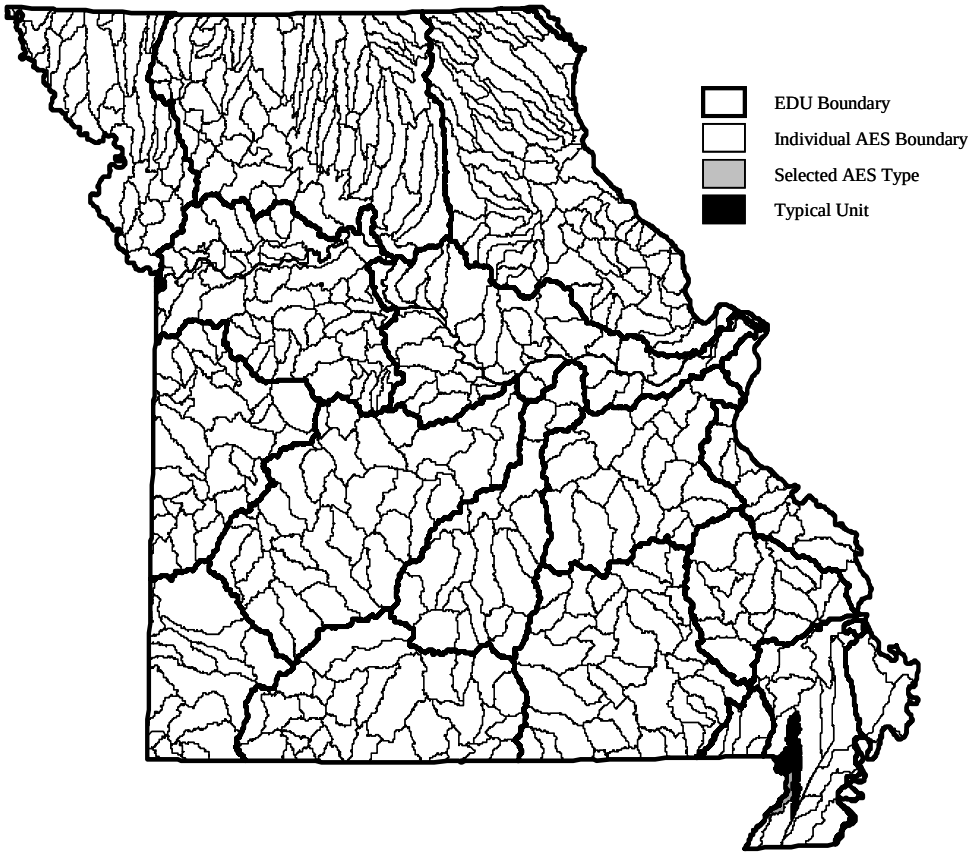
Geographic location:
Restricted to the Mississippi Alluvial Basin Aquatic Subregion.

Ecological Drainage Units in Which This AES-Type Occurs:
Mississippi Alluvial Basin/ St. Francis/ Little EDU.

Description:
This AES-Type transitions between the lower areas to the east and Crowley's Ridge to the west. This Type is located in the central portion of the Mississippi Alluvial Basin with a geographic extent very similar to the Parma Dissected Terrace Land Type Association. Local relief is generally less than 10 feet. The loamy and sandy textured soils exhibit slow to moderate infiltration rates. These soils formed in alluvial deposits. Along the interface with Crowley's Ridge 19 headwater/creek springs issue forth. One individual unit comprises this AES-Type. Groundwater is abundant. The median spring count is 19. The combined headwater and creek mean stream gradient is 2.6 meters per kilometer. Historically, much of the AES was swamp, marsh and bottomland forest.

Typical unit: 510 - City of Gideon

AES-Type 39 (West Ditch)



Geographic location:
Restricted to the Mississippi Alluvial Basin Aquatic Subregion.

Ecological Drainage Units in Which This AES-Type Occurs:
Mississippi Alluvial Basin/ St. Francis/ Little EDU.

Description:
This AES-Type is located between the St Francis River and Little River Ditch. The unit contains a very small portion of Crowley's Ridge. A few headwater tributaries commence on the ridge. Local relief is generally less than 10 feet within this AES-Type. The area comprises a sand and loamy alluvial terrace with bedrock that is very deep. The soil patterns are a result of historic drainage patterns, natural levees, back swamps, and terraces. Surface soil textures are varied and consist of sandy, loamy and clayey soils with moderate to very slow infiltration rates. These soils have developed in alluvial deposits. Historically, the St. Francis River meandered extensively throughout much of this AES. There are no known springs within the two individual units comprising this AES-Type. The combined headwater and creek mean stream gradient is 1.4 meters per kilometer.

Typical unit: 518 – West Ditch and the City of Campbell area

Bibliography of Principal Information Sources

Allgood, E.P., and I.D. Persinger. 1979. Missouri general soil map and soil association descriptions. Columbia: U.S. Department of Agriculture, Soil Conservation Service, in cooperation with Missouri Agricultural Experiment Station.

Anderson, K.H., coordinator. 1979. Geologic map of Missouri. Map at 1:500,000. Rolla: Missouri Department of Natural Resources, Division of Geology and Land Survey.

Bailey, R.G. 1995. Descriptions of the ecoregions of the United States. 2nd rev. ed. (1st ed. 1980). Miscellaneous Publication 1391 (rev.), with map at 1:7,500,000. Washington, D.C.: U.S. Department of Agriculture, Forest Service.

Collier, J.E. 1955. Geographic regions of Missouri. Annals of the Association of American Geographers 45:368-92.

Cozzens, A.B. 1940 Physical profiles of the Ozark province. American Midland Naturalist 24:477-489.

Fenneman, N.M. 1928. Physiographic divisions of the United States. 3d rev. With map at 1:7,000,000. Annals of the Association of American Geographers 18:261-353. Reprinted in The National Atlas of the United States (Washington, D.C.: U.S. Geological Survey, 1985), p. 60.

Fenneman, N.M. 1938. Physiography of the eastern United States. New York: McGraw Hill.

Giessman, N., T. Barney, T. Haithcoat, J. Meyers, and B. Massengale. 1986. Distribution of forest land in Missouri. Transactions of the Missouri Academy of Science 20:5-14.

Küchler, A.W. 1964. The potential natural vegetation of the conterminous United States. With map at 1:3,168,000. New York: American Geographical Society, Special Publication 36.

Küchler, A.W. 1985. Potential natural vegetation. Rev. ed. Map at 1:7,500,000. In The national atlas of the United States of America, 89-91. Washington, D.C.: U.S. Geological Survey.

Missouri Department of Conservation. 2004. Missouri Watersheds. Available online at: http://www.conservation.state.mo.us/fish/watershed/mdc40.htm

Missouri Department of Natural Resources, Geological Survey and Resource Assessment Division. 2002. Springs (digital GIS layer). Rolla, Missouri.

Nelson, P. 1983. The terrestrial natural communities of Missouri. Jefferson City: Missouri Department of Natural Resources.

Nigh, T.A., and W.A. Schroeder. 2002. Atlas of Missouri Ecoregions. Missouri Department of Conservation, Jefferson City, MO.

Omernik, J.M. 1987. Ecoregions of the conterminous United States. Map supplement (1986), at 1:7,500,000. Annals of the Association of American Geographers 77:118-25.

Sauer, C.O. 1920. The geography of the Ozark highland of Missouri. Geographic Society of Chicago Bulletin no. 7. Chicago: University of Chicago Press. Reprint, New York: Greenwood Press, 1968.

Schoolcraft, H.R. 1821. Journal of a tour into the interior of Missouri and Arkansas performed in the years 1818 and 1819. London: Phillips.

Schroeder, W.A. 1981a. Presettlement prairie of Missouri. Natural History Series no. 2. Jefferson City: Missouri Department of Conservation.

Scrivner, C.L., J.C. Baker, and B.J. Miller. 1975. Soils of Missouri. Columbia: University of Missouri, Cooperative Extension Service.

Thom, R.H., and J.H. Wilson. 1980. The natural divisions of Missouri. Transactions of the Missouri Academy of Science 14:9-23.

U.S. Department of Agriculture, Natural Resources Conservation Service. 1994. State Soil Geographic (STATSGO) database for Missouri; 1:250,000. Fort Worth, Texas.

APPENDIX 4.1
Identifying Undersampled Hydrologic Units and Using Them to Modify the Geographic Range of Species

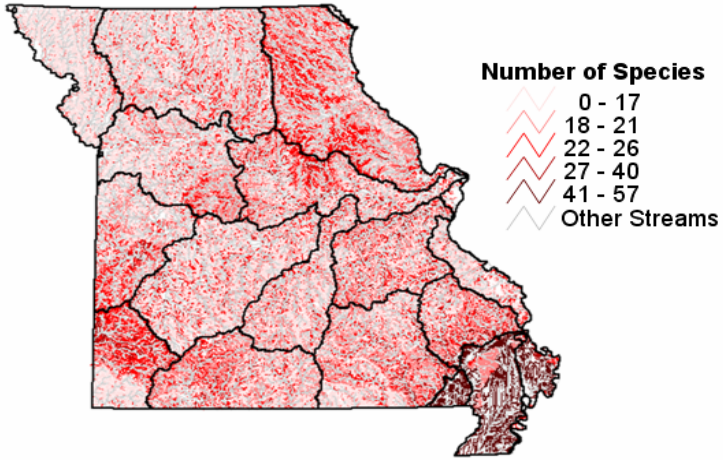
1. First we built contingency tables for each species that showed the percentage of the total samples, falling within each of four stream size categories (Headwater, Creek, Small River, and Large River), in which a given species was collected. Contingency tables were constructed using SAS version 8.02 (SAS 2002). These contingency tables were developed separately for each Aquatic Subregion to account for possible regional differences in the stream sizes typically inhabited by a given species. To build the contingency tables we used all of the samples from those 8-digit HU's in which the species had actually been collected within a given Aquatic Subregion.
2. We then individually examined each of the contingency tables and qualitatively classified each species into more general categories that best reflected the range of stream sizes in which a given species is typically collected: 1) Headwater/Creek; 2) Creek/Small River; 3) Small River/Large River; 4) Headwater/Creek/Small River; 5) Creek/Small River/Large River; and 6) Headwater/Creek/Small River/Large River. Categories 1, 2, and 3 reflect species with relatively restricted distribution patterns with regards to stream size whereas category 6 represents extreme generalists like the green sunfish (*Lepomis cyanellus*) that are consistently found in all stream sizes.
3. We then developed separate ArcView shapefiles that specifically highlighted those 10-digit HU's having five or fewer collections for each of the six categories. These 10-digit HU's are considered undersampled.
4. Next we overlayed the professionally reviewed distribution map of each species on the appropriate "undersampled" shapefile. For example, for the creek chub, which was classified as a "headwater/creek" species we overlayed the 10-digit HU coverage showing the professionally reviewed range onto the shapefile showing those 10-digit HU's having five or fewer collections taken from streams classified as headwaters or creeks.
5. Within those 8-digit HU's where the species is known to occur we then added any undersampled 10-digit HU to the geographic range of the species in which the species had not been collected and that were directly connected or adjacent to 10-digit HU's where the species is known to occur. Thus, we never expanded the distribution of a species into 8-digit HU's where it had not been collected.

This is an admittedly complex process; however, when comparing the final hyperdistributions created by using this process to the one generated with the data from the professional review we are confident that our approach offers a significantly more accurate representation of the spatial distribution of fishes across Missouri. We recognize that detection probabilities are species specific and vary due to an assortment of factors related to environmental conditions, sampling methods, and most importantly the distribution and abundance patterns a species exhibits at multiple spatial scales (Huston 2002). Although ideal,

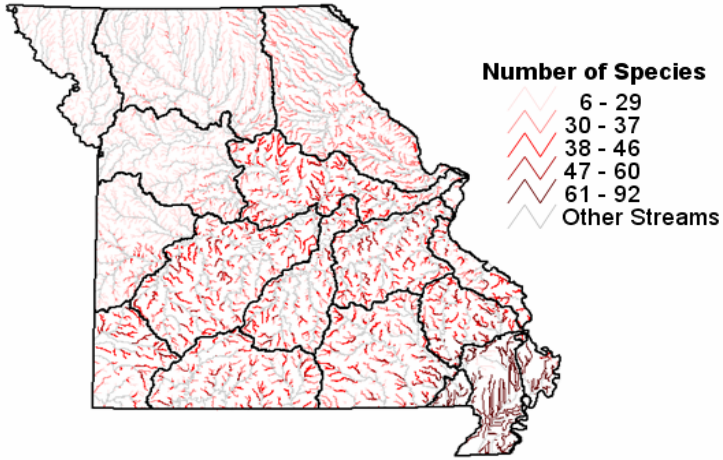
developing species-specific detection criteria to identify undersampled 10-digit HU's separately for each species, was not an option for this project.

APPENDIX 4.2
Richness Maps by Stream Size Class and Taxon

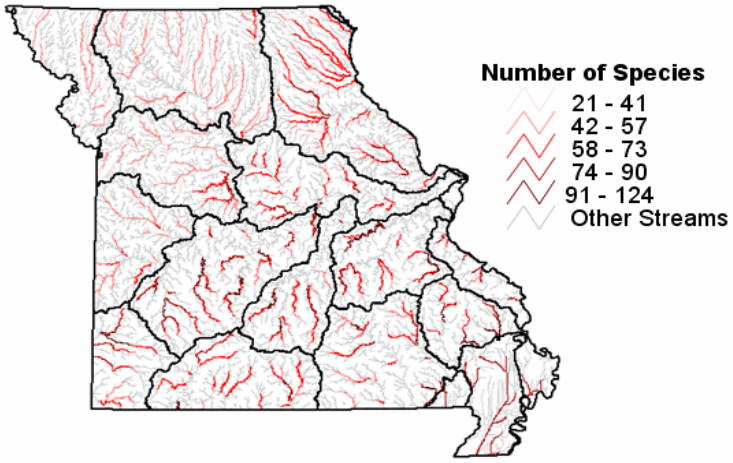
Headwater Modeled Species Richness
Crayfish, Fish, and Mussels



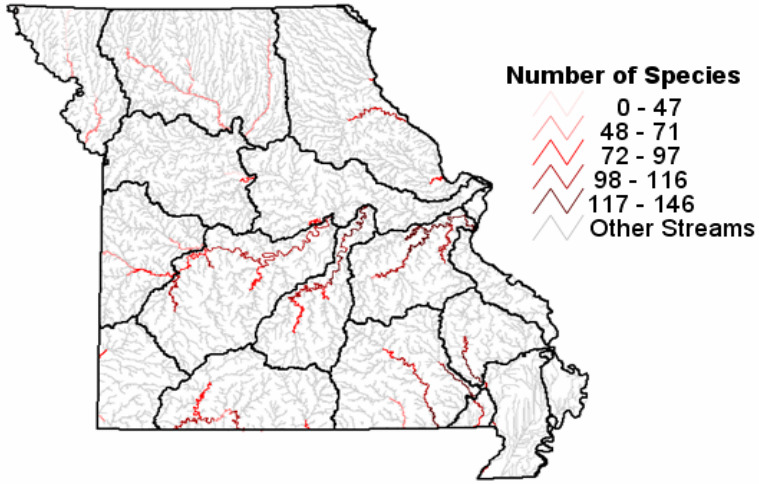
Creek Modeled Species Richness
Crayfish, Fish, and Mussels



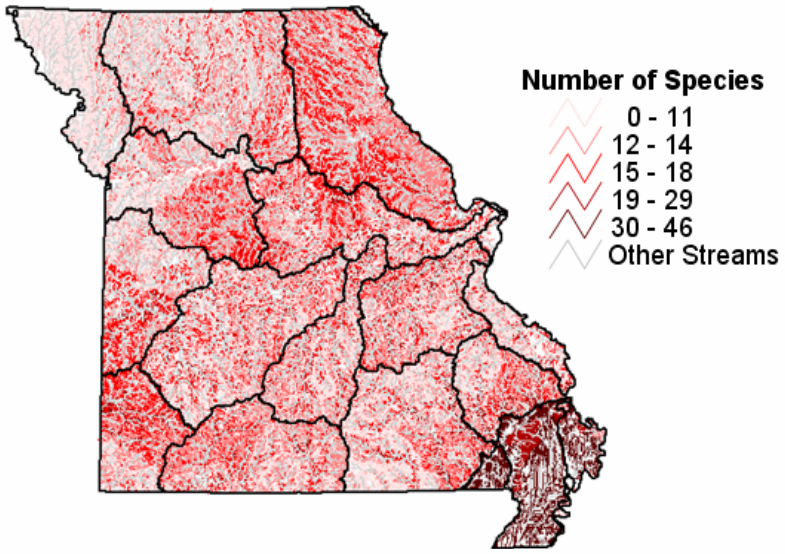
Small River Modeled Species Richness
Crayfish, Fish, and Mussels



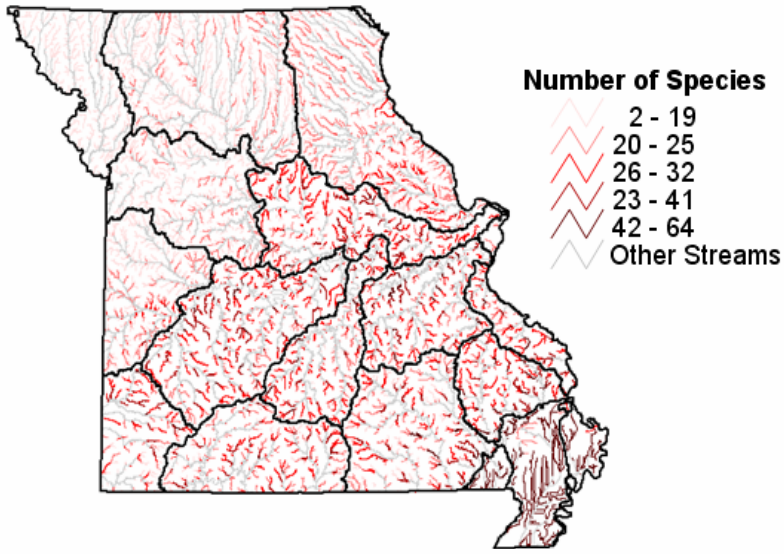
Large River Modeled Species Richness
Crayfish, Fish, and Mussels



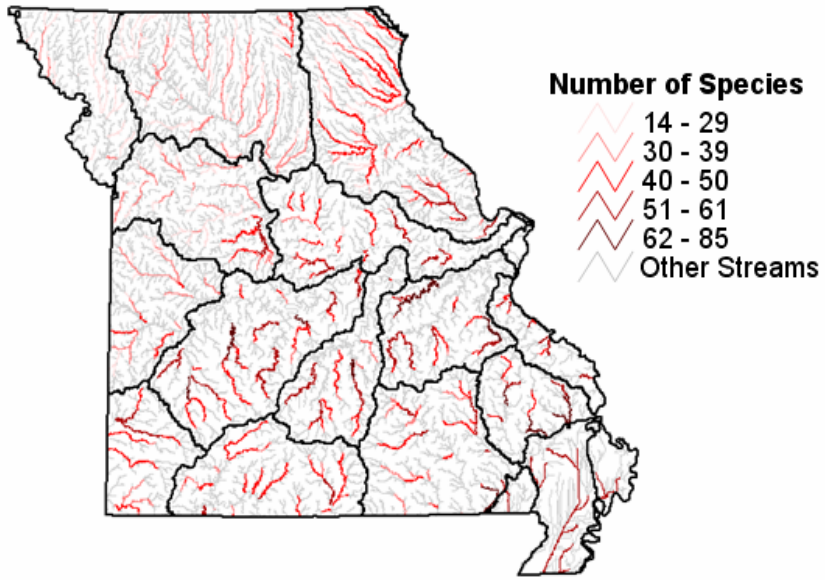
Headwater Modeled Fish Richness



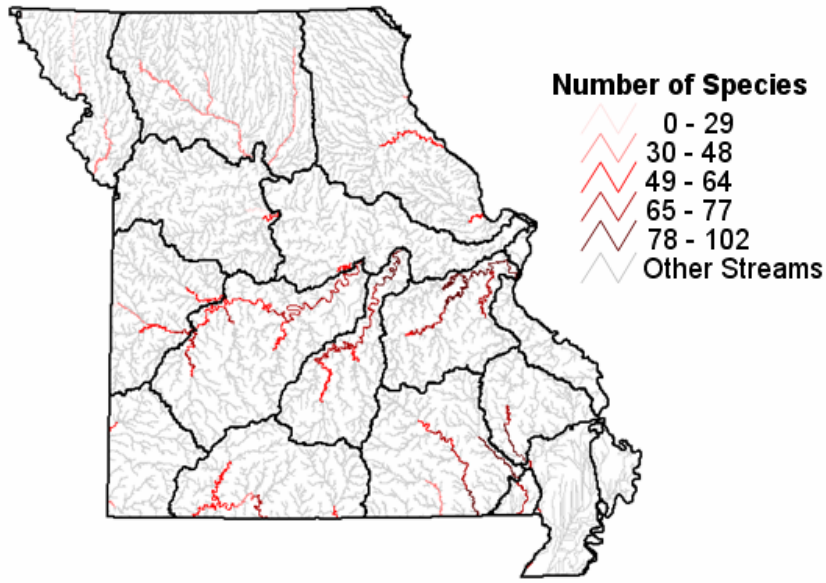
Creek Modeled Fish Richness



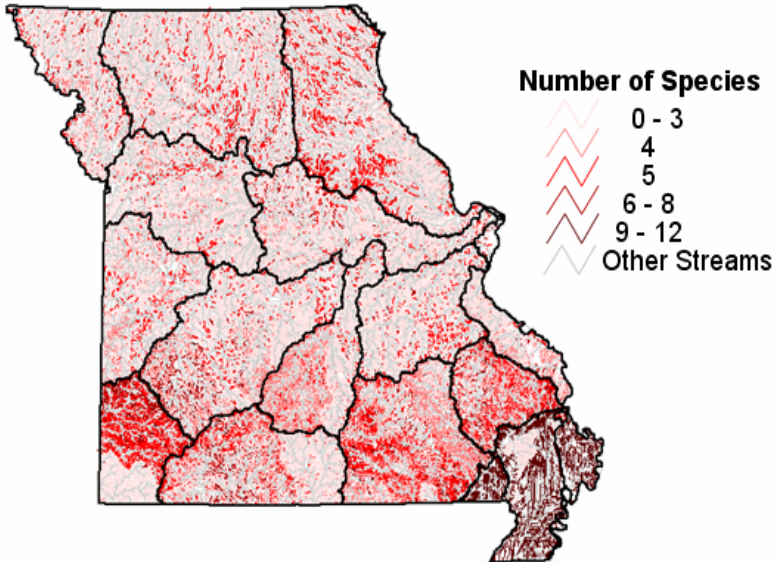
Small River Modeled Fish Richness



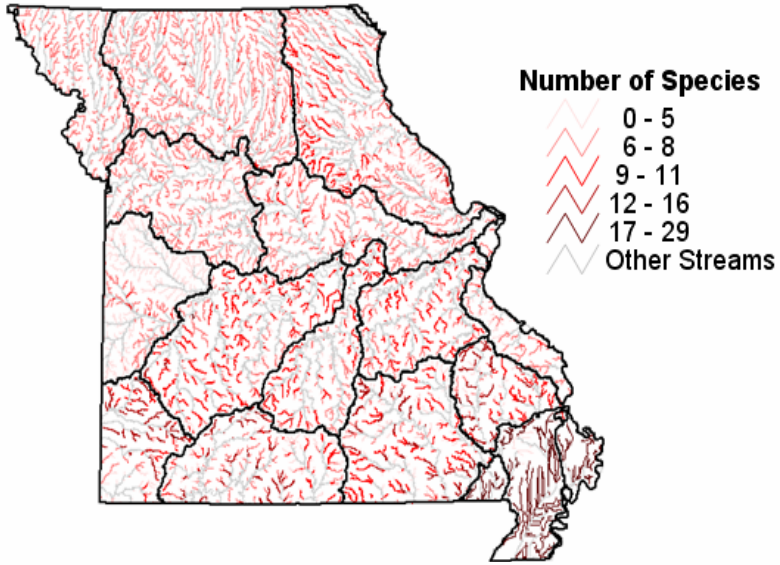
Large River Modeled Fish Richness



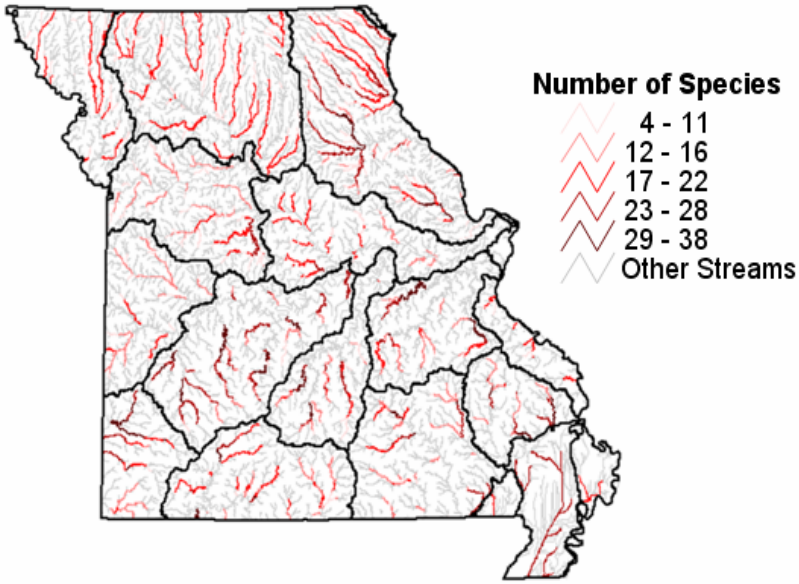
Headwater Modeled Mussel Richness



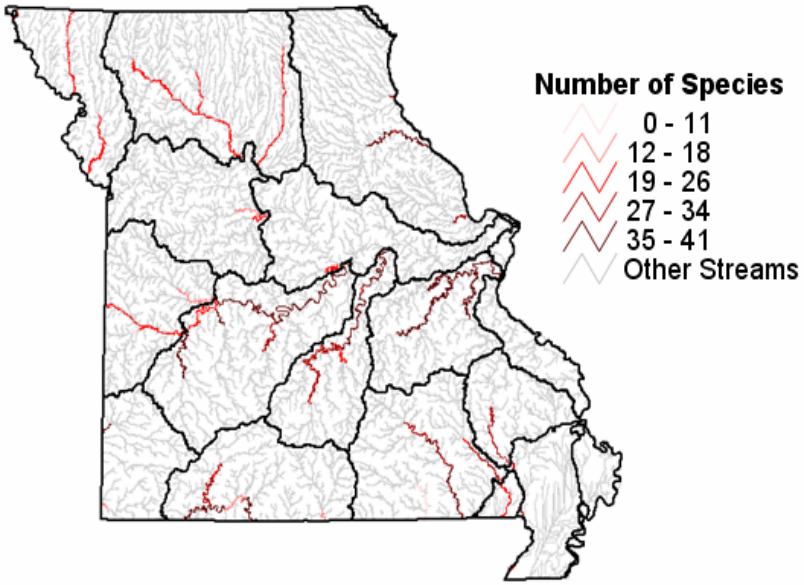
Creek Modeled Mussel Richness



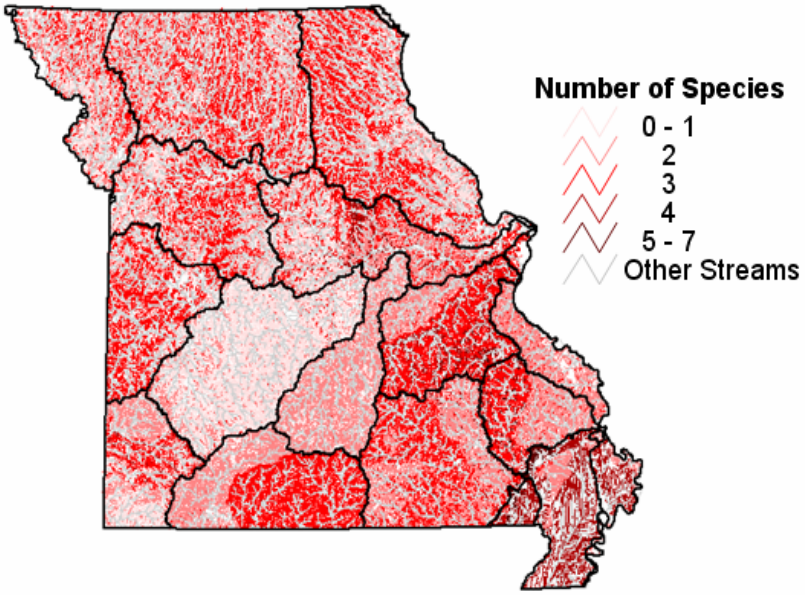
Small River Modeled Mussel Richness



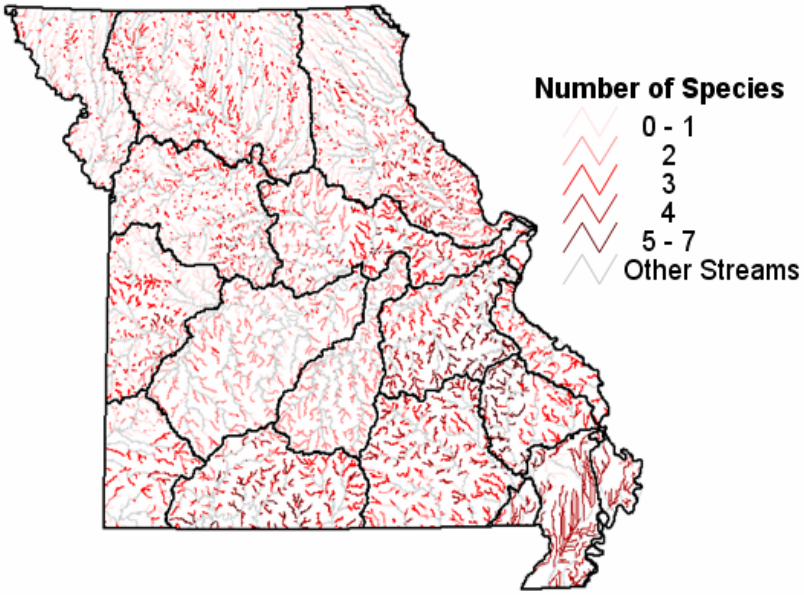
Large River Modeled Mussel Richness



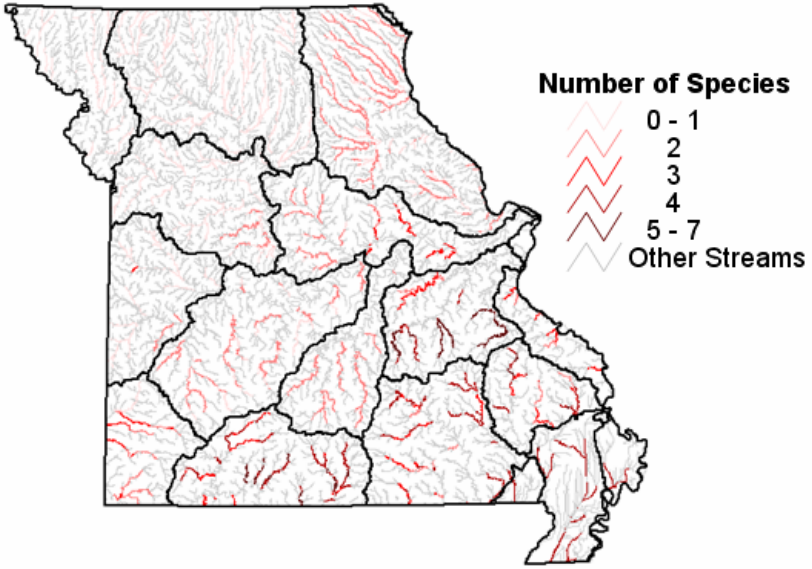
Headwater Modeled Crayfish Richness



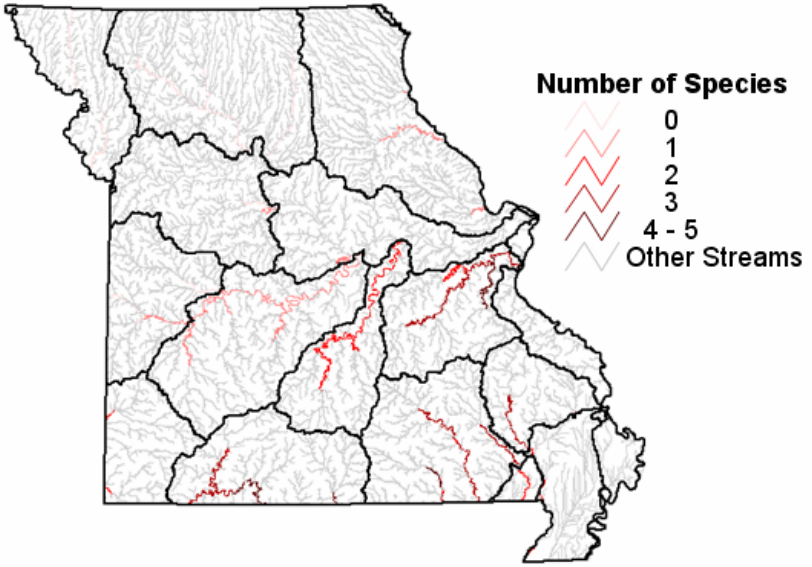
Creek Modeled Crayfish Richness



Small River Modeled Crayfish Richness



Large River Modeled Crayfish Richness



APPENDIX 6.1
List of the 65 Individual Human Stressor Metrics that Were Generated for Each AES Polygon in Missouri

Generated by using EPA's ATtILA 3.0 software

Percent Forest
Percent wetland
Percent urban
Percent agriculture as pasture
Percent agriculture as cropland
Percent agriculture total
Percent barren
Human use index
Percent shrubland
Percent natural land cover
Percent Agriculture on slopes >= 5%
Percent Agriculture as pasture on slopes >= 5%
Percent Agriculture as cropland on slopes >= 5%
Percent riparian area in agriculture as cropland (immediate buffer)
Percent riparian area in agriculture as pasture (immediate buffer)
Percent riparian area in agriculture total (immediate buffer)
Percent riparian area in urban (immediate buffer)
Percent riparian area in human use index (immediate buffer)
Percent riparian area in agriculture as cropland (immediate buffer)
Percent riparian area in forest (immediate buffer)
Percent riparian area in shrub (immediate buffer)
Percent riparian area in barren (immediate buffer)
Percent riparian area in natural grasses (immediate buffer)
Percent riparian area in wetland (immediate buffer)
Percent riparian area in agriculture as cropland (30 meter buffer)
Percent riparian area in agriculture as pasture (30 meter buffer)
Percent riparian area in agriculture total (30 meter buffer)
Percent riparian area in urban (30 meter buffer)
Percent riparian area in human use index (30 meter buffer)
Percent riparian area in agriculture as cropland (30 meter buffer)
Percent riparian area in forest (30 meter buffer)
Percent riparian area in shrub (30 meter buffer)
Percent riparian area in barren (30 meter buffer)
Percent riparian area in natural grasses (30 meter buffer)
Percent riparian area in wetland (30 meter buffer)
Road density
Density of roads in close proximity (30 meters) of streams
Road length
Road density by road class
Percent impervious surface based on roads
Percent impervious surface based on land cover
Density of stream/road crossings
Number of stream/road crossings
2000 population density
Population change (1990-2000)
Modeled Phosphorous load
Modeled Nitrogen load
Nitrogen INDEX

APPENDIX 6.1 Continued

Generated using data contained in EPA Basins 3.1 and GIS datalayers developed explicitly for Missouri

Density of coal mines
Density of lead mines
Density of gravel mines
Density of all mines
Density of Toxic Release inventory sites
Density of Leaky underground storage tanks
Density of industrial facility discharges
Density of municipal discharges
Density of landfills
Density of confined animal feeding operations
Density of hazardous waste generating facilities
Density of hazardous solution generating facilities
Density of small impoundments
Number of nonnative species

Categorical; Generated by Visual Examination of an overlay of High Pool Reservoir Boundaries and AES polygon boundaries

Hydrologically modified by impoundments (1 or 0)
Fragmented by impoundments (1 or 0)
Isolated by impoundments (1 or 0)

APPENDIX 7.1

Statewide management status statistics for each fish, mussel, and crayfish species in Missouri, by length. Table shows the total length of stream in which each species is predicted to occur and the length and percent of total that occurs within each management status category. *Note: Asterisk denotes nonnative species*

			Status 1		Status 2		Status 3		Status 4	
Common	Scientific	Total Km	Km	%	Km	%	Km	%	Km	%
Fish										
Alabama shad	Alosa alabamae	1355	1	0.07	0	0	15	1.11	0	0
alligator gar	Atractosteus spatula	483	0	0	0	0	0	0	0	0
American brook lamprey	Lampetra appendix	336	12	3.57	122	36.31	26	7.74	0	0
American eel	Anguilla rostrata	3806	54	1.42	155	4.07	123	3.23	3	0.08
Arkansas darter	Etheostoma cragini	4709	3	0.06	0	0	30	0.64	0	0
Arkansas saddled darter	Etheostoma euzonum	429	12	2.8	90	20.98	18	4.2	0	0
banded darter	Etheostoma zonale	5189	66	1.27	207	3.99	234	4.51	0	0
banded pygmy sunfish	Elassoma zonatum	8448	7	0.08	48	0.57	127	1.5	0	0
banded sculpin	Cottus carolinae	21381	191	0.89	401	1.88	1382	6.46	0	0
bantam sunfish	Lepomis symmetricus	95	2	2.11	40	42.11	14	14.74	0	0
bigeye chub	Notropis amblops	5100	69	1.35	227	4.45	310	6.08	0	0
bigeye shiner	Notropis boops	9341	70	0.75	227	2.43	398	4.26	0	0
bighead carp*	Hypophthalmichthys nobilis	1926	1	0.05	0	0	14	0.73	3	0.16
bigmouth buffalo	Ictiobus cyprinellus	13204	39	0.3	222	1.68	396	3	3	0.02
bigmouth shiner	Notropis dorsalis	47919	24	0.05	85	0.18	622	1.3	12	0.03
black buffalo	Ictiobus niger	6047	15	0.25	146	2.41	175	2.89	0	0
black bullhead	Ameiurus melas	130252	120	0.09	384	0.29	3945	3.03	12	0.01
black crappie	Pomoxis nigromaculatus	5588	18	0.32	151	2.7	180	3.22	3	0.05
black redhorse	Moxostoma duquesnei	8963	71	0.79	264	2.95	469	5.23	0	0
blacknose shiner	Notropis heterolepis	2728	7	0.26	2	0.07	108	3.96	0	0
blackside darter	Percina maculata	9015	9	0.1	48	0.53	200	2.22	0	0
blackspotted topminnow	Fundulus olivaceus	25396	139	0.55	347	1.37	872	3.43	0	0
blackstripe topminnow	Fundulus notatus	28726	19	0.07	79	0.28	633	2.2	0	0

Appendix 7.1. Continued.

Common	Scientific	Total Km	Status 1		Status 2		Status 3		Status 4	
			Km	%	Km	%	Km	%	Km	%
blacktail shiner	Cyprinella venusta	8679	14	0.16	50	0.58	200	2.3	0	0
bleeding shiner	Luxilus zonatus	12793	115	0.9	286	2.24	631	4.93	0	0
blue catfish	Ictalurus furcatus	2444	1	0.04	0	0	23	0.94	3	0.12
blue sucker	Cycleptus elongatus	2939	13	0.44	29	0.99	43	1.46	3	0.1
bluegill	Lepomis macrochirus	173682	546	0.31	797	0.46	7985	4.6	49	0.03
bluestripe darter	Percina cymatotaenia	1339	2	0.15	37	2.76	36	2.69	0	0
bluntface shiner	Cyprinella camura	681	0	0	0	0	6	0.88	0	0
bluntnose darter	Etheostoma chlorosomum	12238	9	0.07	48	0.39	235	1.92	0	0
bluntnose minnow	Pimephales notatus	125488	261	0.21	520	0.41	3350	2.67	11	0.01
bowfin	Amia calva	2014	3	0.15	5	0.25	75	3.72	0	0
brassy minnow	Hybognathus hankinsoni	2546	0	0	0	0	43	1.69	0	0
brindled madtom	Noturus miurus	1188	0	0	1	0.08	69	5.81	0	0
brook darter	Etheostoma burri	3062	32	1.05	37	1.21	634	20.71	0	0
brook silverside	Labidesthes sicculus	23162	78	0.34	252	1.09	689	2.97	0	0
brown bullhead	Ameiurus nebulosus	109	0	0	43	39.45	10	9.17	0	0
brown trout*	Salmo trutta	209	0	0	26	12.44	26	12.44	0	0
bullhead minnow	Pimephales vigilax	11039	10	0.09	53	0.48	224	2.03	0	0
burbot	Lota lota	519	0	0	0	0	0	0	3	0.58
cardinal shiner	Luxilus cardinalis	5947	3	0.05	0	0	52	0.87	0	0
central mudminnow	Umbra limi	10	0	0	0	0	0	0	0	0
central stoneroller	Campostoma anomalum	161362	537	0.33	726	0.45	7806	4.84	46	0.03
chain pickerel	Esox niger	1740	92	5.29	233	13.39	277	15.92	0	0
channel catfish	Ictalurus punctatus	17098	49	0.29	214	1.25	534	3.12	3	0.02
channel darter	Percina copelandi	535	0	0	0	0	6	1.12	0	0
channel shiner	Notropis wickliffi	1088	1	0.09	0	0	0	0	0	0
checkered madtom	Noturus flavater	1069	29	2.71	134	12.54	57	5.33	0	0
chestnut lamprey	Ichthyomyzon castaneus	5231	23	0.44	141	2.7	210	4.01	3	0.06
common carp*	Cyprinus carpio	40150	96	0.24	316	0.79	1099	2.74	3	0.01
common shiner	Luxilus cornutus	27481	8	0.03	21	0.08	496	1.8	9	0.03
creek chub	Semotilus atromaculatus	159085	510	0.32	639	0.4	7620	4.79	46	0.03
creek chubsucker	Erimyzon oblongus	36602	319	0.87	473	1.29	4086	11.16	0	0
crystal darter	Crystallaria asprella	1400	2	0.14	2	0.14	58	4.14	0	0
Current darter	Etheostoma uniporum	11018	208	1.89	248	2.25	2095	19.01	0	0

Appendix 7.1. Continued.

Common	Scientific	Total Km	Status 1		Status 2		Status 3		Status 4	
			Km	%	Km	%	Km	%	Km	%
cypress darter	Etheostoma proeliare	10117	11	0.11	50	0.49	197	1.95	0	0
cypress minnow	Hybognathus hayi	250	0	0	0	0	6	2.4	0	0
dollar sunfish	Lepomis marginatus	7	0	0	0	0	5	71.43	0	0
dusky darter	Percina sciera	8230	9	0.11	50	0.61	144	1.75	0	0
duskystripe shiner	Luxilus pilsbryi	12017	158	1.31	121	1.01	1082	9	37	0.31
emerald shiner	Notropis atherinoides	9316	13	0.14	40	0.43	248	2.66	3	0.03
fantail darter	Etheostoma flabellare	87084	401	0.46	505	0.58	6455	7.41	18	0.02
fathead minnow	Pimephales promelas	80137	29	0.04	94	0.12	1333	1.66	12	0.01
flathead catfish	Pylodictis olivaris	10664	33	0.31	122	1.14	331	3.1	3	0.03
flathead chub	Platygobio gracilis	1724	1	0.06	0	0	15	0.87	3	0.17
flier	Centrarchus macropterus	2614	10	0.38	18	0.69	49	1.87	0	0
freckled madtom	Noturus nocturnus	2802	16	0.57	33	1.18	184	6.57	0	0
freshwater drum	Aplodinotus grunniens	12012	33	0.27	197	1.64	366	3.05	3	0.02
ghost shiner	Notropis buchanani	5753	2	0.03	5	0.09	189	3.29	3	0.05
gilt darter	Percina evides	2068	15	0.73	160	7.74	104	5.03	0	0
gizzard shad	Dorosoma cepedianum	21834	93	0.43	317	1.45	592	2.71	3	0.01
golden redhorse	Moxostoma erythrurum	11100	68	0.61	227	2.05	479	4.32	0	0
golden shiner	Notemigonus crysoleucas	43298	22	0.05	108	0.25	811	1.87	9	0.02
golden topminnow	Fundulus chrysotus	32	0	0	0	0	0	0	0	0
goldeye	Hiodon alosoides	4258	15	0.35	11	0.26	149	3.5	0	0
goldfish*	Carassius auratus	50	0	0	1	2	1	2	0	0
goldstripe darter	Etheostoma parvipinne	14	0	0	0	0	2	14.29	0	0
grass carp*	Ctenopharyngodon idella	1564	1	0.06	0	0	0	0	3	0.19
grass pickerel	Esox americanus	36280	172	0.47	264	0.73	2882	7.94	19	0.05
gravel chub	Erimystax x-punctatus	3473	5	0.14	37	1.07	150	4.32	0	0
green sunfish	Lepomis cyanellus	173546	546	0.31	797	0.46	7974	4.59	49	0.03
greenside darter	Etheostoma blennioides	8075	70	0.87	264	3.27	451	5.59	0	0
harlequin darter	Etheostoma histrio	237	0	0	0	0	6	2.53	0	0
highfin carpsucker	Carpiodes velifer	2407	13	0.54	71	2.95	84	3.49	0	0
hornyhead chub	Nocomis biguttatus	41015	368	0.9	501	1.22	3558	8.67	8	0.02
inland silverside	Menidia beryllina	144	0	0	0	0	0	0	0	0
ironcolor shiner	Notropis chalybaeus	2555	0	0	0	0	13	0.51	0	0
Johnny darter	Etheostoma nigrum	52783	35	0.07	84	0.16	925	1.75	0	0

Appendix 7.1. Continued.

Common	Scientific	Total Km	Status 1		Status 2		Status 3		Status 4	
			Km	%	Km	%	Km	%	Km	%
lake chubsucker	Erimyzon sucetta	4455	7	0.16	18	0.4	53	1.19	0	0
lake sturgeon	Acipenser fulvescens	1548	1	0.06	0	0	0	0	3	0.19
largemouth bass	Micropterus salmoides	75254	165	0.22	435	0.58	1934	2.57	12	0.02
largescale stoneroller	Campostoma oligolepis	16783	154	0.92	311	1.85	866	5.16	0	0
least brook lamprey	Lampetra aepyptera	7282	76	1.04	194	2.66	533	7.32	3	0.04
least darter	Etheostoma microperca	3336	1	0.03	1	0.03	132	3.96	0	0
logperch	Percina caprodes	15137	56	0.37	133	0.88	632	4.18	0	0
longear sunfish	Lepomis megalotis	53550	260	0.49	487	0.91	2729	5.1	6	0.01
longnose darter	Percina nasuta	271	0	0	0	0	27	9.96	0	0
longnose gar	Lepisosteus osseus	16796	44	0.26	223	1.33	413	2.46	3	0.02
mimic shiner	Notropis volucellus	4482	4	0.09	36	0.8	130	2.9	0	0
Mississippi silvery minnow	Hybognathus nuchalis	1630	12	0.74	72	4.42	69	4.23	0	0
Missouri saddled darter	Etheostoma tetrazonum	3757	5	0.13	44	1.17	148	3.94	0	0
mooneye	Hiodon tergisus	2185	17	0.78	84	3.84	67	3.07	0	0
mottled sculpin	Cottus bairdi	8143	21	0.26	56	0.69	394	4.84	0	0
mountain madtom	Noturus eleutherus	18	0	0	0	0	1	5.56	0	0
mud darter	Etheostoma asprigene	1472	2	0.14	2	0.14	18	1.22	0	0
Neosho madtom	Noturus placidus	5	0	0	0	0	0	0	0	0
Niangua darter	Etheostoma nianguae	1331	0	0	0	0	66	4.96	0	0
northern brook lamprey	Ichthyomyzon fossor	867	5	0.58	38	4.38	15	1.73	0	0
northern hog sucker	Hypentelium nigricans	8743	70	0.8	266	3.04	468	5.35	0	0
northern pike	Esox lucius	545	0	0	0	0	15	2.75	0	0
northern studfish	Fundulus catenatus	16534	153	0.93	309	1.87	880	5.32	0	0
orangespotted sunfish	Lepomis humilis	39484	35	0.09	103	0.26	983	2.49	9	0.02
orangethroat darter	Etheostoma spectabile	116690	264	0.23	299	0.26	4656	3.99	46	0.04
Ozark bass	Ambloplites constellatus	1915	3	0.16	17	0.89	143	7.47	0	0
Ozark chub	Erimystax harryi	1644	19	1.16	211	12.83	146	8.88	0	0
Ozark madtom	Noturus albater	1888	56	2.97	211	11.18	211	11.18	0	0
Ozark minnow	Notropis nubilus	32584	243	0.75	457	1.4	2082	6.39	0	0
Ozark sculpin	Cottus hypselurus	3186	66	2.07	233	7.31	215	6.75	0	0
Ozark shiner	Notropis ozarcanus	785	26	3.31	132	16.82	55	7.01	0	0
paddlefish	Polyodon spathula	3780	16	0.42	122	3.23	129	3.41	3	0.08
pallid shiner	Notropis amnis	1756	2	0.11	2	0.11	63	3.59	0	0

Appendix 7.1. Continued.

Common	Scientific	Total Km	Status 1		Status 2		Status 3		Status 4	
			Km	%	Km	%	Km	%	Km	%
pallid sturgeon	Scaphirhynchus albus	1381	1	0.07	0	0	0	0	3	0.22
pirate perch	Aphredoderus sayanus	18160	32	0.18	166	0.91	1307	7.2	0	0
plains killifish	Fundulus zebrinus	18	0	0	0	0	0	0	0	0
plains minnow	Hybognathus placitus	4825	16	0.33	6	0.12	98	2.03	3	0.06
plains topminnow	Fundulus sciadicus	20295	51	0.25	48	0.24	875	4.31	0	0
pugnose minnow	Opsopoeodus emiliae	8466	20	0.24	77	0.91	167	1.97	0	0
pumpkinseed	Lepomis gibbosus	4	0	0	0	0	0	0	0	0
quillback	Carpiodes cyprinus	10162	22	0.22	30	0.3	325	3.2	0	0
rainbow darter	Etheostoma caeruleum	11603	122	1.05	298	2.57	629	5.42	0	0
rainbow smelt*	Osmerus mordax	1175	1	0.09	0	0	0	0	0	0
rainbow trout*	Oncorhynchus mykiss	591	35	5.92	26	4.4	60	10.15	0	0
red shiner	Cyprinella lutrensis	80807	27	0.03	78	0.1	1414	1.75	3	0
redear sunfish	Lepomis microlophus	1803	19	1.05	93	5.16	111	6.16	0	0
redfin darter	Etheostoma whipplei	86	0	0	0	0	0	0	0	0
redfin shiner	Lythrurus umbratilis	67230	130	0.19	371	0.55	1607	2.39	9	0.01
redspot chub	Nocomis asper	1295	0	0	0	0	13	1	0	0
redspotted sunfish	Lepomis miniatus	11543	126	1.09	239	2.07	549	4.76	0	0
ribbon shiner	Lythrurus fumeus	7799	11	0.14	48	0.62	121	1.55	0	0
river carpsucker	Carpiodes carpio	10833	24	0.22	43	0.4	335	3.09	3	0.03
river darter	Percina shumardi	1657	2	0.12	2	0.12	22	1.33	0	0
river redhorse	Moxostoma carinatum	3589	16	0.45	129	3.59	139	3.87	0	0
river shiner	Notropis blennius	2325	7	0.3	9	0.39	23	0.99	7	0.3
rock bass	Ambloplites rupestris	3934	5	0.13	44	1.12	118	3	0	0
rosyface shiner	Notropis rubellus	7133	67	0.94	260	3.65	352	4.93	0	0
Sabine shiner	Notropis sabinae	60	0	0	0	0	0	0	0	0
saddleback darter	Percina vigil	2709	2	0.07	30	1.11	69	2.55	0	0
sand shiner	Notropis stramineus	34464	32	0.09	61	0.18	867	2.52	12	0.03
sauger	Stizostedion canadense	3515	14	0.4	116	3.3	111	3.16	3	0.09
scaly sand darter	Ammocrypta vivax	1125	2	0.18	2	0.18	74	6.58	0	0
shadow bass	Ambloplites ariommus	8337	81	0.97	272	3.26	235	2.82	0	0
shoal chub	Macrhybopsis hyostoma	3102	1	0.03	0	0	26	0.84	3	0.1
shorthead redhorse	Moxostoma macrolepidotum	12343	85	0.69	270	2.19	474	3.84	0	0
shortnose gar	Lepisosteus platostomus	8552	22	0.26	33	0.39	265	3.1	3	0.04

Appendix 7.1. Continued.

Common	Scientific	Total Km	Status 1		Status 2		Status 3		Status 4	
			Km	%	Km	%	Km	%	Km	%
shovelnose sturgeon	Scaphirhynchus platorynchus	2004	4	0.2	0	0	2	0.1	3	0.15
sicklefin chub	Macrhybopsis meeki	1322	1	0.08	0	0	0	0	3	0.23
silver carp*	Hypophthalmichthys molitrix	1564	1	0.06	0	0	0	0	3	0.19
silver chub	Macrhybopsis storeriana	3751	16	0.43	0	0	107	2.85	3	0.08
silver lamprey	Ichthyomyzon unicuspis	367	0	0	0	0	0	0	0	0
silver redhorse	Moxostoma anisurum	4486	18	0.4	78	1.74	223	4.97	0	0
silverband shiner	Notropis shumardi	1045	1	0.1	0	0	0	0	0	0
silverjaw minnow	Notropis buccatus	1846	0	0	0	0	77	4.17	0	0
skipjack herring	Alosa chrysochloris	2322	16	0.69	116	5	37	1.59	3	0.13
slender madtom	Noturus exilis	16717	56	0.33	220	1.32	720	4.31	0	0
slenderhead darter	Percina phoxocephala	6093	5	0.08	38	0.62	223	3.66	0	0
slim minnow	Pimephales tenellus	1068	2	0.19	8	0.75	78	7.3	0	0
slough darter	Etheostoma gracile	17525	16	0.09	50	0.29	410	2.34	0	0
smallmouth bass	Micropterus dolomieu	12408	94	0.76	291	2.35	626	5.05	0	0
smallmouth buffalo	Ictiobus bubalus	9480	18	0.19	49	0.52	286	3.02	3	0.03
southern brook lamprey	Ichthyomyzon gagei	3485	4	0.11	12	0.34	195	5.6	0	0
southern redbelly dace	Phoxinus erythrogaster	71504	449	0.63	414	0.58	5997	8.39	37	0.05
speckled darter	Etheostoma stigmaeum	9030	11	0.12	51	0.56	146	1.62	0	0
spotfin shiner	Cyprinella spiloptera	3002	5	0.17	48	1.6	51	1.7	0	0
spottail shiner	Notropis hudsonius	573	0	0	0	0	0	0	0	0
spotted bass	Micropterus punctulatus	14604	24	0.16	86	0.59	356	2.44	0	0
spotted gar	Lepisosteus oculatus	8678	10	0.12	91	1.05	101	1.16	0	0
spotted sucker	Minytrema melanops	10307	13	0.13	54	0.52	153	1.48	0	0
stargazing darter	Percina uranidea	115	3	2.61	0	0	4	3.48	0	0
starhead topminnow	Fundulus dispar	342	4	1.17	0	0	12	3.51	0	0
steelcolor shiner	Cyprinella whipplei	2444	13	0.53	41	1.68	85	3.48	0	0
stippled darter	Etheostoma punctulatum	49616	298	0.6	340	0.69	3167	6.38	37	0.07
stonecat	Noturus flavus	7791	19	0.24	45	0.58	258	3.31	3	0.04
striped bass*	Morone saxatilis	618	1	0.16	0	0	0	0	0	0
striped mullet	Mugil cephalus	387	0	0	0	0	0	0	0	0
striped shiner	Luxilus chrysocephalus	23742	211	0.89	427	1.8	1544	6.5	0	0
sturgeon chub	Macrhybopsis gelida	1209	1	0.08	0	0	0	0	3	0.25
suckermouth minnow	Phenacobius mirabilis	23039	19	0.08	71	0.31	606	2.63	3	0.01

Appendix 7.1. Continued.

Common	Scientific	Total Km	Status 1		Status 2		Status 3		Status 4	
			Km	%	Km	%	Km	%	Km	%
swamp darter	Etheostoma fusiforme	1	0	0	0	0	0	0	0	0
tadpole madtom	Noturus gyrinus	16162	15	0.09	50	0.31	416	2.57	0	0
taillight shiner	Notropis maculatus	237	0	0	0	0	6	2.53	0	0
telescope shiner	Notropis telescopus	5119	106	2.07	252	4.92	381	7.44	0	0
threadfin shad	Dorosoma petenense	367	0	0	0	0	14	3.81	0	0
Topeka shiner	Notropis topeka	9531	4	0.04	2	0.02	138	1.45	0	0
trout-perch	Percopsis omiscomaycus	4207	15	0.36	22	0.52	89	2.12	4	0.1
walleye	Stizostedion vitreum	4904	54	1.1	151	3.08	202	4.12	0	0
warmouth	Chaenobryttus gulosus	18884	136	0.72	232	1.23	909	4.81	0	0
wedgespot shiner	Notropis greenei	4360	25	0.57	231	5.3	231	5.3	0	0
weed shiner	Notropis texanus	7894	11	0.14	48	0.61	117	1.48	0	0
western mosquitofish	Gambusia affinis	49570	72	0.15	203	0.41	1399	2.82	9	0.02
western sand darter	Ammocrypta clara	1525	2	0.13	2	0.13	63	4.13	0	0
western silvery minnow	Hybognathus argyritis	4670	10	0.21	13	0.28	53	1.13	12	0.26
white bass	Morone chrysops	4433	13	0.29	29	0.65	150	3.38	3	0.07
white crappie	Pomoxis annularis	18336	35	0.19	103	0.56	513	2.8	6	0.03
white sucker	Catostomus commersoni	141436	367	0.26	348	0.25	6435	4.55	46	0.03
whitetail shiner	Cyprinella galactura	2407	21	0.87	188	7.81	221	9.18	0	0
yellow bass	Morone mississippiensis	839	0	0	0	0	0	0	0	0
yellow bullhead	Ameiurus natalis	47969	203	0.42	423	0.88	1673	3.49	6	0.01
yellow perch	Perca flavescens	5	0	0	0	0	0	0	0	0
yoke darter	Etheostoma juliae	1131	3	0.27	14	1.24	65	5.75	0	0
Mussel										
Arkansas brokenray	Lampsilis reeveiana reeveiana	2386	37	1.55	139	5.83	132	5.53	0	0
Asian clam*	Corbicula fluminea	13902	48	0.35	223	1.6	354	2.55	0	0
bankclimber	Plectomerus dombeyanus	812	2	0.25	2	0.25	18	2.22	0	0
black sandshell	Ligumia recta	3798	53	1.4	165	4.34	204	5.37	0	0
bleedingtooth mussel	Venustaconcha pleasi	5328	87	1.63	235	4.41	345	6.48	0	0
bleufer	Potamilus purpuratus	10036	25	0.25	220	2.19	225	2.24	0	0
butterfly	Ellipsaria lineolata	2044	15	0.73	97	4.75	69	3.38	0	0
creeper	Strophitus undulatus	48752	84	0.17	376	0.77	1322	2.71	9	0.02
Curtis pearlymussel	Epioblasma florentina curtisii	711	12	1.69	106	14.91	25	3.52	0	0
cylindrical papershell	Anodontoides ferussacianus	2908	0	0	5	0.17	63	2.17	0	0

Appendix 7.1. Continued.

Common	Scientific	Total Km	Status 1		Status 2		Status 3		Status 4	
			Km	%	Km	%	Km	%	Km	%
deertoe	Truncilla truncata	4911	23	0.47	158	3.22	282	5.74	0	0
ebonyshell	Fusconaia ebena	385	3	0.78	19	4.94	12	3.12	0	0
elephantear	Elliptio crassidens	1320	3	0.23	5	0.38	39	2.95	0	0
elktoe	Alasmidonta marginata	6265	26	0.42	231	3.69	297	4.74	0	0
ellipse	Venustaconcha ellipsiformis	14505	19	0.13	54	0.37	523	3.61	0	0
fat pocketbook	Potamilus capax	4	0	0	0	0	0	0	0	0
fatmucket	Lampsilis siliquoidea	156834	501	0.32	723	0.46	7703	4.91	46	0.03
fawnsfoot	Truncilla donaciformis	2798	15	0.54	148	5.29	175	6.25	0	0
flat floater	Anodonta suborbiculata	9555	17	0.18	37	0.39	273	2.86	0	0
flutedshell	Lasmigona costata	6784	36	0.53	237	3.49	353	5.2	0	0
fragile papershell	Leptodea fragilis	18622	42	0.23	224	1.2	500	2.68	0	0
giant floater	Pyganodon grandis	167307	444	0.27	680	0.41	7489	4.48	46	0.03
hickorynut	Obovaria olivaria	264	0	0	0	0	0	0	0	0
Higgins eye	Lampsilis higginsii	31	0	0	0	0	0	0	0	0
lilliput	Toxolasma parvus	41313	85	0.21	327	0.79	1124	2.72	2	0
little spectaclecase	Villosa lienosa	30023	158	0.53	259	0.86	2701	9	15	0.05
mapleleaf	Quadrula quadrula	16303	26	0.16	73	0.45	441	2.71	0	0
monkeyface	Quadrula metanevra	3410	11	0.32	39	1.14	168	4.93	0	0
mucket	Actinonaias ligamentina	4720	16	0.34	170	3.6	230	4.87	0	0
Neosho mucket	Lampsilis rafinesqueana	988	0	0	2	0.2	42	4.25	0	0
northern brokenray	Lampsilis reeveiana brittsi	9381	17	0.18	46	0.49	398	4.24	0	0
Ouachita kidneyshell	Ptychobranchus occidentalis	23745	127	0.53	311	1.31	1193	5.02	3	0.01
Ozark brokenray	Lampsilis reeveiana brevicula	7253	90	1.24	241	3.32	457	6.3	0	0
Ozark pigtoe	Fusconaia ozarkensis	4027	65	1.61	240	5.96	180	4.47	0	0
paper pondshell	Utterbackia imbecillis	50934	101	0.2	344	0.68	1464	2.87	9	0.02
pimpleback	Quadrula pustulosa	11421	32	0.28	154	1.35	379	3.32	0	0
pink heelsplitter	Potamilus alatus	9117	19	0.21	50	0.55	331	3.63	0	0
pink mucket	Lampsilis abrupta	1252	11	0.88	33	2.64	43	3.43	0	0
pink papershell	Potamilus ohiensis	8246	19	0.23	13	0.16	279	3.38	0	0
pistolgrip	Tritogonia verrucosa	12168	33	0.27	208	1.71	433	3.56	0	0
plain pocketbook	Lampsilis cardium	17329	56	0.32	309	1.78	699	4.03	0	0
pondhorn	Uniomerus tetralasmus	19607	16	0.08	67	0.34	551	2.81	6	0.03
pondmussel	Ligumia subrostrata	160890	457	0.28	570	0.35	7339	4.56	46	0.03

Appendix 7.1. Continued.

Common	Scientific	Total Km	Status 1		Status 2		Status 3		Status 4	
			Km	%	Km	%	Km	%	Km	%
purple lilliput	Toxolasma lividus	2338	10	0.43	74	3.17	138	5.9	0	0
purple wartyback	Cyclonaias tuberculata	2133	17	0.8	108	5.06	92	4.31	0	0
rabbitsfoot	Quadrula cylindrica cylindrica	816	12	1.47	124	15.2	84	10.29	0	0
rainbow	Villosa iris	8188	119	1.45	254	3.1	544	6.64	0	0
rock pocketbook	Arcidens confragosus	3128	5	0.16	49	1.57	76	2.43	0	0
round pigtoe	Pleurobema sintoxia	4574	24	0.52	172	3.76	234	5.12	0	0
salamander mussel	Simpsonaias ambigua	560	3	0.54	0	0	30	5.36	0	0
scaleshell	Leptodea leptodon	1239	3	0.24	5	0.4	20	1.61	0	0
sheepnose	Plethobasus cyphyus	1046	3	0.29	5	0.48	28	2.68	0	0
slippershell mussel	Alasmidonta viridis	10517	58	0.55	138	1.31	500	4.75	3	0.03
snuffbox	Epioblasma triquetra	921	3	0.33	2	0.22	55	5.97	0	0
southern hickorynut	Obovaria jacksoniana	299	0	0	0	0	20	6.69	0	0
spectaclecase	Cumberlandia monodonta	1348	3	0.22	18	1.34	44	3.26	0	0
spike	Elliptio dilatata	6193	26	0.42	186	3	260	4.2	0	0
Texas lilliput	Toxolasma texasensis	725	0	0	0	0	9	1.24	0	0
threehorn wartyback	Obliquaria reflexa	9610	24	0.25	145	1.51	251	2.61	0	0
threeridge	Amblema plicata	17584	40	0.23	226	1.29	489	2.78	0	0
Wabash pigtoe	Fusconaia flava	13402	36	0.27	220	1.64	448	3.34	0	0
wartyback	Quadrula nodulata	4626	2	0.04	40	0.86	128	2.77	0	0
washboard	Megalonaias nervosa	3386	13	0.38	33	0.97	151	4.46	0	0
western fanshell	Cyprogenia aberti	1376	12	0.87	124	9.01	107	7.78	0	0
white heelsplitter	Lasmigona complanata	16763	39	0.23	167	1	423	2.52	0	0
yellow sandshell	Lampsilis teres	12804	25	0.2	96	0.75	418	3.26	0	0
zebra mussel*	Dreissena polymorpha	867	0	0	0	0	15	1.73	0	0
Crayfish										
belted crayfish	Orconectes harrisonii	531	0	0	2	0.38	7	1.32	0	0
Big Creek crayfish	Orconectes peruncus	675	0	0	10	1.48	54	8	0	0
Cajun dwarf crayfish	Cambarellus puer	16	0	0	0	0	0	0	0	0
coldwater crayfish	Orconectes eupunctus	75	35	46.67	0	0	3	4	0	0
devil crayfish	Cambarus diogenes	56569	197	0.35	247	0.44	4268	7.54	0	0
digger crayfish	Fallicambarus fodiens	6	0	0	0	0	0	0	0	0
freckled crayfish	Cambarus maculatus	1591	5	0.31	7	0.44	117	7.35	0	0
golden crayfish	Orconectes luteus	24562	71	0.29	324	1.32	1036	4.22	2	0.01

Appendix 7.1. Continued.

Common	Scientific	Total Km	Status 1		Status 2		Status 3		Status 4	
			Km	%	Km	%	Km	%	Km	%
grassland crayfish	Procambarus gracilis	35544	13	0.04	15	0.04	374	1.05	5	0.01
gray-speckled crayfish	Orconectes palmeri	8696	9	0.1	50	0.57	102	1.17	0	0
Hubbs' crayfish	Cambarus hubbsi	1493	44	2.95	55	3.68	109	7.3	0	0
longpincered crayfish	Orconectes longidigitus	1201	3	0.25	16	1.33	82	6.83	0	0
Mammoth Spring crayfish	Orconectes marchandi	12	0	0	0	0	0	0	0	0
Meek's crayfish	Orconectes meeki	126	0	0	0	0	32	25.4	0	0
Neosho midget crayfish	Orconectes macrus	1161	0	0	0	0	14	1.21	0	0
Ozark crayfish	Orconectes ozarkae	15920	333	2.09	378	2.37	2471	15.52	34	0.21
papershell crayfish	Orconectes immunis	48971	19	0.04	65	0.13	572	1.17	9	0.02
red swamp crayfish	Procambarus clarkii	7475	9	0.12	48	0.64	83	1.11	0	0
ringed crayfish	Orconectes neglectus	17568	160	0.91	121	0.69	1130	6.43	37	0.21
saddlebacked crayfish	Orconectes medius	7977	7	0.09	36	0.45	798	10	0	0
shield crayfish	Faxonella clypeata	963	0	0	50	5.19	70	7.27	0	0
shrimp crayfish	Orconectes lancifer	96	0	0	0	0	0	0	0	0
Shufeldt's dwarf crayfish	Cambarellus shufeldtii	7402	9	0.12	48	0.65	93	1.26	0	0
spothanded crayfish	Orconectes punctimanus	58414	456	0.78	664	1.14	5895	10.09	37	0.06
St. Francis River crayfish	Orconectes quadruncus	3225	12	0.37	66	2.05	372	11.53	0	0
vernal crayfish	Procambarus viaeviridis	5	0	0	2	40	2	40	0	0
virile crayfish	Orconectes virilis	91821	110	0.12	221	0.24	2203	2.4	11	0.01
white river crayfish	Procambarus acutus	95	0	0	0	0	12	12.63	0	0
Williams' crayfish	Orconectes williamsi	296	0	0	0	0	37	12.5	0	0
woodland crayfish	Orconectes hylas	2044	2	0.1	25	1.22	180	8.81	0	0

APPENDIX 7.2

Statewide management status statistics for each fish, mussel, and crayfish species in Missouri, by length. Table shows the total length of stream in which each species is predicted to occur and the length and percent of total that occurs within either status 1 or 2 lands or status 3 or 4 lands. *Note: Asterisk denotes nonnative species*

			Status 1 or 2		Status 3 or 4		Public	
Common	**Scientific**	**Total Km**	**Km**	**%**	**Km**	**%**	**Km**	**%**
Fish								
alligator gar	Atractosteus spatula	483	0	0	0	0	0	0
bluntface shiner	Cyprinella camura	681	0	0	6.41	0.94	6.41	0.94
brassy minnow	Hybognathus hankinsoni	2546	0	0	42.55	1.67	42.55	1.67
burbot	Lota lota	519	0	0	3.47	0.67	3.47	0.67
central mudminnow	Umbra limi	10	0	0	0	0	0	0
channel darter	Percina copelandi	535	0	0	6.41	1.2	6.41	1.2
cypress minnow	Hybognathus hayi	250	0	0	6.16	2.47	6.16	2.47
dollar sunfish	Lepomis marginatus	7	0	0	4.85	69.36	4.85	69.36
golden topminnow	Fundulus chrysotus	32	0	0	0	0	0	0
goldstripe darter	Etheostoma parvipinne	14	0	0	1.87	13.35	1.87	13.35
harlequin darter	Etheostoma histrio	237	0	0	6.16	2.6	6.16	2.6
inland silverside	Menidia beryllina	144	0	0	0	0	0	0
ironcolor shiner	Notropis chalybaeus	2555	0	0	13.03	0.51	13.03	0.51
longnose darter	Percina nasuta	271	0	0	27.00	9.96	27.00	9.96
mountain madtom	Noturus eleutherus	18	0	0	1.35	7.51	1.35	7.51
Neosho madtom	Noturus placidus	5	0	0	0	0	0	0
Niangua darter	Etheostoma nianguae	1331	0	0	66.15	4.97	66.15	4.97
northern pike	Esox lucius	545	0	0	15.08	2.77	15.08	2.77
plains killifish	Fundulus zebrinus	18	0	0	0	0	0	0
pumpkinseed	Lepomis gibbosus	4	0	0	0	0	0	0
redfin darter	Etheostoma whipplei	86	0	0	0	0	0	0
redspot chub	Nocomis asper	1295	0	0	13.19	1.02	13.19	1.02
Sabine shiner	Notropis sabinae	60	0	0	0	0	0	0
silver lamprey	Ichthyomyzon unicuspis	367	0	0	0	0	0	0

Appendix 7.2. Continued.

			Status 1 or 2		Status 3 or 4		Public	
Common	**Scientific**	**Total Km**	**Km**	**%**	**Km**	**%**	**Km**	**%**
silverjaw minnow	Notropis buccatus	1846	0	0	76.62	4.15	76.62	4.15
spottail shiner	Notropis hudsonius	573	0	0	0	0	0	0
striped mullet	Mugil cephalus	387	0	0	0	0	0	0
swamp darter	Etheostoma fusiforme	1	0	0	0	0	0	0
taillight shiner	Notropis maculatus	237	0	0	6.16	2.6	6.16	2.6
threadfin shad	Dorosoma petenense	367	0	0	13.85	3.77	13.85	3.77
yellow bass	Morone mississippiensis	839	0	0	0	0	0	0
yellow perch	Perca flavescens	5	0	0	0	0	0	0
least darter	Etheostoma microperca	3336	0.62	0.02	132.03	3.96	132.65	3.98
Alabama shad	Alosa alabamae	1355	1.38	0.1	15.04	1.11	16.42	1.21
bighead carp*	Hypophthalmichthys nobilis	1926	1.38	0.07	17.31	0.9	18.69	0.97
blue catfish	Ictalurus furcatus	2444	1.38	0.06	26.07	1.07	27.45	1.12
channel shiner	Notropis wickliffi	1088	1.38	0.13	0	0	1.38	0.13
flathead chub	Platygobio gracilis	1724	1.38	0.08	18.86	1.09	20.24	1.17
grass carp*	Ctenopharyngodon idella	1564	1.38	0.09	3.47	0.22	4.85	0.31
lake sturgeon	Acipenser fulvescens	1548	1.38	0.09	3.47	0.22	4.85	0.31
pallid sturgeon	Scaphirhynchus albus	1381	1.38	0.1	3.47	0.25	4.85	0.35
rainbow smelt*	Osmerus mordax	1175	1.38	0.12	0	0	1.38	0.12
shoal chub	Macrhybopsis hyostoma	3102	1.38	0.04	29.07	0.94	30.45	0.98
sicklefin chub	Macrhybopsis meeki	1322	1.38	0.1	3.47	0.26	4.85	0.37
silver carp*	Hypophthalmichthys molitrix	1564	1.38	0.09	3.47	0.22	4.85	0.31
silverband shiner	Notropis shumardi	1045	1.38	0.13	0	0	1.38	0.13
striped bass*	Morone saxatilis	618	1.38	0.22	0	0	1.38	0.22
sturgeon chub	Macrhybopsis gelida	1209	1.38	0.11	3.47	0.29	4.85	0.4
brindled madtom	Noturus miurus	1188	1.42	0.12	69.40	5.84	70.82	5.96
goldfish*	Carassius auratus	50	1.45	2.89	0.93	1.85	2.37	4.75
stargazing darter	Percina uranidea	115	2.59	2.25	3.92	3.41	6.51	5.66
Arkansas darter	Etheostoma cragini	4709	2.72	0.06	30.37	0.64	33.09	0.7
cardinal shiner	Luxilus cardinalis	5947	2.72	0.05	52.34	0.88	55.05	0.93
shovelnose sturgeon	Scaphirhynchus platorynchus	2004	3.97	0.2	5.94	0.3	9.91	0.49
crystal darter	Crystallaria asprella	1400	4.05	0.29	58.00	4.14	62.05	4.43
mud darter	Etheostoma asprigene	1472	4.05	0.27	17.95	1.22	22.00	1.49
pallid shiner	Notropis amnis	1756	4.05	0.23	63.27	3.6	67.31	3.83

Appendix 7.2. Continued.

			Status 1 or 2		Status 3 or 4		Public	
Common	**Scientific**	**Total Km**	**Km**	**%**	**Km**	**%**	**Km**	**%**
river darter	Percina shumardi	1657	4.05	0.24	21.87	1.32	25.92	1.56
scaly sand darter	Ammocrypta vivax	1125	4.05	0.36	74.11	6.59	78.16	6.95
western sand darter	Ammocrypta clara	1525	4.05	0.27	63.05	4.13	67.10	4.4
starhead topminnow	Fundulus dispar	342	4.12	1.21	12.12	3.55	16.25	4.75
Topeka shiner	Notropis topeka	9531	5.40	0.06	138.36	1.45	143.76	1.51
ghost shiner	Notropis buchanani	5753	6.56	0.11	192.48	3.35	199.03	3.46
bowfin	Amia calva	2014	7.50	0.37	75.40	3.74	82.90	4.12
blacknose shiner	Notropis heterolepis	2728	8.66	0.32	107.74	3.95	116.40	4.27
slim minnow	Pimephales tenellus	1068	9.25	0.87	77.81	7.29	87.05	8.15
southern brook lamprey	Ichthyomyzon gagei	3485	15.87	0.46	195.10	5.6	210.97	6.05
river shiner	Notropis blennius	2325	16.19	0.7	30.56	1.31	46.75	2.01
silver chub	Macrhybopsis storeriana	3751	16.45	0.44	110.85	2.96	127.29	3.39
yoke darter	Etheostoma juliae	1131	17.26	1.53	65.09	5.76	82.36	7.28
Ozark bass	Ambloplites constellatus	1915	20.37	1.06	142.87	7.46	163.25	8.52
plains minnow	Hybognathus placitus	4825	22.10	0.46	101.11	2.1	123.21	2.55
western silvery minnow	Hybognathus argyritis	4670	22.38	0.48	65.81	1.41	88.19	1.89
lake chubsucker	Erimyzon sucetta	4455	24.94	0.56	53.08	1.19	78.03	1.75
goldeye	Hiodon alosoides	4258	25.64	0.6	149.23	3.5	174.87	4.11
brown trout*	Salmo trutta	209	26.17	12.52	26.23	12.55	52.40	25.07
flier	Centrarchus macropterus	2614	28.00	1.07	49.21	1.88	77.21	2.95
common shiner	Luxilus cornutus	27481	28.30	0.1	505.28	1.84	533.59	1.94
saddleback darter	Percina vigil	2709	31.66	1.17	68.92	2.54	100.58	3.71
trout-perch	Percopsis omiscomaycus	4207	37.09	0.88	93.02	2.21	130.11	3.09
bluestripe darter	Percina cymatotaenia	1339	39.01	2.91	35.74	2.67	74.75	5.58
mimic shiner	Notropis volucellus	4482	40.87	0.91	130.50	2.91	171.36	3.82
blue sucker	Cycleptus elongatus	2939	41.74	1.42	46.35	1.58	88.09	3
white bass	Morone chrysops	4433	41.74	0.94	153.38	3.46	195.12	4.4
bantam sunfish	Lepomis symmetricus	95	41.98	44.19	14.14	14.88	56.11	59.07
gravel chub	Erimystax x-punctatus	3473	42.11	1.21	149.80	4.31	191.91	5.53
brown bullhead	Ameiurus nebulosus	109	42.74	39.21	10.15	9.31	52.90	48.53
northern brook lamprey	Ichthyomyzon fossor	867	43.03	4.96	14.95	1.72	57.98	6.69
slenderhead darter	Percina phoxocephala	6093	43.68	0.72	222.76	3.66	266.43	4.37
Missouri saddled darter	Etheostoma tetrazonum	3757	48.26	1.28	147.97	3.94	196.23	5.22

Appendix 7.2. Continued.

			Status 1 or 2		Status 3 or 4		Public	
Common	**Scientific**	**Total Km**	**Km**	**%**	**Km**	**%**	**Km**	**%**
rock bass	Ambloplites rupestris	3934	48.31	1.23	117.84	3	166.15	4.22
freckled madtom	Noturus nocturnus	2802	48.70	1.74	184.08	6.57	232.78	8.31
quillback	Carpiodes cyprinus	10162	51.65	0.51	325.09	3.2	376.74	3.71
emerald shiner	Notropis atherinoides	9316	53.18	0.57	251.25	2.7	304.43	3.27
spotfin shiner	Cyprinella spiloptera	3002	53.51	1.78	50.90	1.7	104.41	3.48
steelcolor shiner	Cyprinella whipplei	2444	54.49	2.23	84.99	3.48	139.48	5.71
shortnose gar	Lepisosteus platostomus	8552	54.81	0.64	268.26	3.14	323.07	3.78
banded pygmy sunfish	Elassoma zonatum	8448	54.90	0.65	126.55	1.5	181.44	2.15
blackside darter	Percina maculata	9015	56.94	0.63	200.21	2.22	257.15	2.85
bluntnose darter	Etheostoma chlorosomum	12238	57.07	0.47	234.66	1.92	291.73	2.38
dusky darter	Percina sciera	8230	58.49	0.71	144.33	1.75	202.82	2.46
ribbon shiner	Lythrurus fumeus	7799	59.66	0.76	120.64	1.55	180.30	2.31
weed shiner	Notropis texanus	7894	59.66	0.76	116.95	1.48	176.60	2.24
rainbow trout*	Oncorhynchus mykiss	591	60.94	10.31	59.71	10.1	120.64	20.41
cypress darter	Etheostoma proeliare	10117	61.53	0.61	196.89	1.95	258.42	2.55
speckled darter	Etheostoma stigmaeum	9030	62.32	0.69	145.80	1.61	208.12	2.3
bullhead minnow	Pimephales vigilax	11039	63.36	0.57	223.97	2.03	287.33	2.6
blacktail shiner	Cyprinella venusta	8679	64.09	0.74	200.46	2.31	264.55	3.05
stonecat	Noturus flavus	7791	64.16	0.82	261.36	3.35	325.53	4.18
tadpole madtom	Noturus gyrinus	16162	64.21	0.4	415.81	2.57	480.02	2.97
slough darter	Etheostoma gracile	17525	66.47	0.38	409.73	2.34	476.20	2.72
river carpsucker	Carpiodes carpio	10833	66.50	0.61	338.57	3.13	405.07	3.74
spotted sucker	Minytrema melanops	10307	66.87	0.65	152.95	1.48	219.81	2.13
smallmouth buffalo	Ictiobus bubalus	9480	67.01	0.71	289.78	3.06	356.79	3.76
brook darter	Etheostoma burri	3062	68.92	2.25	633.94	20.7	702.87	22.95
mottled sculpin	Cottus bairdi	8143	77.14	0.95	393.50	4.83	470.64	5.78
Mississippi silvery minnow	Hybognathus nuchalis	1630	84.03	5.16	69.46	4.26	153.50	9.42
highfin carpsucker	Carpiodes velifer	2407	84.51	3.51	83.72	3.48	168.23	6.99
suckermouth minnow	Phenacobius mirabilis	23039	89.50	0.39	609.08	2.64	698.59	3.03
sand shiner	Notropis stramineus	34464	92.87	0.27	879.32	2.55	972.20	2.82
silver redhorse	Moxostoma anisurum	4486	96.12	2.14	222.96	4.97	319.08	7.11
pugnose minnow	Opsopoeodus emiliae	8466	97.43	1.15	166.95	1.97	264.38	3.12
blackstripe topminnow	Fundulus notatus	28726	97.78	0.34	633.15	2.2	730.93	2.54

Appendix 7.2. Continued.

			Status 1 or 2		Status 3 or 4		Public	
Common	**Scientific**	**Total Km**	**Km**	**%**	**Km**	**%**	**Km**	**%**
plains topminnow	Fundulus sciadicus	20295	99.25	0.49	874.53	4.31	973.77	4.8
spotted gar	Lepisosteus oculatus	8678	100.74	1.16	101.09	1.16	201.83	2.33
mooneye	Hiodon tergisus	2185	101.16	4.63	66.94	3.06	168.10	7.69
Arkansas saddled darter	Etheostoma euzonum	429	102.07	23.79	17.64	4.11	119.71	27.9
red shiner	Cyprinella lutrensis	80807	104.83	0.13	1417.50	1.75	1522.33	1.88
bigmouth shiner	Notropis dorsalis	47919	108.09	0.23	634.88	1.32	742.97	1.55
spotted bass	Micropterus punctulatus	14604	109.86	0.75	355.75	2.44	465.61	3.19
redear sunfish	Lepomis microlophus	1803	112.19	6.22	110.86	6.15	223.05	12.37
Johnny darter	Etheostoma nigrum	52783	118.87	0.23	925.22	1.75	1044.09	1.98
fathead minnow	Pimephales promelas	80137	122.99	0.15	1345.80	1.68	1468.79	1.83
sauger	Stizostedion canadense	3515	129.57	3.69	114.59	3.26	244.16	6.95
golden shiner	Notemigonus crysoleucas	43298	130.27	0.3	820.40	1.89	950.67	2.2
skipjack herring	Alosa chrysochloris	2322	132.18	5.69	40.53	1.75	172.71	7.44
American brook lamprey	Lampetra appendix	336	134.32	39.98	25.59	7.62	159.91	47.59
white crappie	Pomoxis annularis	18336	138.28	0.75	518.28	2.83	656.56	3.58
orangespotted sunfish	Lepomis humilis	39484	138.32	0.35	991.67	2.51	1129.99	2.86
paddlefish	Polyodon spathula	3780	138.58	3.67	132.46	3.5	271.04	7.17
river redhorse	Moxostoma carinatum	3589	144.92	4.04	138.80	3.87	283.72	7.91
flathead catfish	Pylodictis olivaris	10664	154.24	1.45	334.17	3.13	488.42	4.58
Ozark shiner	Notropis ozarcanus	785	157.92	20.12	54.73	6.97	212.65	27.09
black buffalo	Ictiobus niger	6047	161.23	2.67	174.63	2.89	335.86	5.55
checkered madtom	Noturus flavater	1069	163.56	15.3	56.95	5.33	220.51	20.63
chestnut lamprey	Ichthyomyzon castaneus	5231	164.10	3.14	213.52	4.08	377.62	7.22
black crappie	Pomoxis nigromaculatus	5588	168.53	3.02	183.69	3.29	352.21	6.3
gilt darter	Percina evides	2068	175.27	8.48	104.20	5.04	279.47	13.51
logperch	Percina caprodes	15137	188.98	1.25	631.64	4.17	820.62	5.42
pirate perch	Aphredoderus sayanus	18160	198.17	1.09	1306.96	7.2	1505.13	8.29
walleye	Stizostedion vitreum	4904	204.83	4.18	202.12	4.12	406.95	8.3
whitetail shiner	Cyprinella galactura	2407	209.30	8.7	220.91	9.18	430.20	17.87
American eel	Anguilla rostrata	3806	209.44	5.5	126.96	3.34	336.40	8.84
freshwater drum	Aplodinotus grunniens	12012	230.24	1.92	369.15	3.07	599.39	4.99
Ozark chub	Erimystax harryi	1644	230.42	14.02	146.12	8.89	376.53	22.9
wedgespot shiner	Notropis greenei	4360	255.92	5.87	230.70	5.29	486.62	11.16

Appendix 7.2. Continued.

			Status 1 or 2		Status 3 or 4		Public	
Common	**Scientific**	**Total Km**	**Km**	**%**	**Km**	**%**	**Km**	**%**
bigmouth buffalo	Ictiobus cyprinellus	13204	261.31	1.98	399.78	3.03	661.09	5.01
channel catfish	Ictalurus punctatus	17098	263.03	1.54	537.27	3.14	800.30	4.68
longnose gar	Lepisosteus osseus	16796	267.21	1.59	416.30	2.48	683.50	4.07
Ozark madtom	Noturus albater	1888	267.30	14.16	211.12	11.18	478.42	25.34
least brook lamprey	Lampetra aepyptera	7282	270.45	3.71	535.21	7.35	805.66	11.06
banded darter	Etheostoma zonale	5189	272.93	5.26	233.59	4.5	506.52	9.76
western mosquitofish	Gambusia affinis	49570	274.53	0.55	1407.82	2.84	1682.35	3.39
slender madtom	Noturus exilis	16717	276.34	1.65	719.96	4.31	996.30	5.96
duskystripe shiner	Luxilus pilsbryi	12017	279.09	2.32	1118.83	9.31	1397.92	11.63
golden redhorse	Moxostoma erythrurum	11100	294.84	2.66	478.97	4.32	773.81	6.97
bigeye chub	Notropis amblops	5100	296.59	5.82	310.32	6.08	606.91	11.9
bigeye shiner	Notropis boops	9341	296.88	3.18	397.80	4.26	694.68	7.44
Ozark sculpin	Cottus hypselurus	3186	298.14	9.36	215.16	6.75	513.31	16.11
chain pickerel	Esox niger	1740	324.72	18.66	276.97	15.92	601.69	34.58
rosyface shiner	Notropis rubellus	7133	326.76	4.58	351.51	4.93	678.27	9.51
brook silverside	Labidesthes sicculus	23162	329.81	1.42	688.94	2.97	1018.75	4.4
greenside darter	Etheostoma blennioides	8075	334.82	4.15	450.68	5.58	785.50	9.73
black redhorse	Moxostoma duquesnei	8963	335.64	3.74	469.02	5.23	804.66	8.98
northern hog sucker	Hypentelium nigricans	8743	336.44	3.85	468.30	5.36	804.74	9.2
shadow bass	Ambloplites ariommus	8337	352.72	4.23	235.00	2.82	587.72	7.05
shorthead redhorse	Moxostoma macrolepidotum	12343	354.68	2.87	474.47	3.84	829.15	6.72
telescope shiner	Notropis telescopus	5119	357.98	6.99	380.97	7.44	738.95	14.44
redspotted sunfish	Lepomis miniatus	11543	365.09	3.16	549.00	4.76	914.09	7.92
warmouth	Chaenobryttus gulosus	18884	368.26	1.95	909.10	4.81	1277.36	6.76
smallmouth bass	Micropterus dolomieu	12408	384.99	3.1	626.43	5.05	1011.42	8.15
bleeding shiner	Luxilus zonatus	12793	400.36	3.13	630.59	4.93	1030.95	8.06
gizzard shad	Dorosoma cepedianum	21834	409.55	1.88	595.12	2.73	1004.67	4.6
common carp*	Cyprinus carpio	40150	411.69	1.03	1102.65	2.75	1514.34	3.77
rainbow darter	Etheostoma caeruleum	11603	419.62	3.62	628.82	5.42	1048.45	9.04
grass pickerel	Esox americanus	36280	436.42	1.2	2900.75	8	3337.18	9.2
Current darter	Etheostoma uniporum	11018	455.76	4.14	2094.65	19.01	2550.40	23.15
northern studfish	Fundulus catenatus	16534	461.94	2.79	879.51	5.32	1341.45	8.11
largescale stoneroller	Campostoma oligolepis	16783	464.91	2.77	866.07	5.16	1330.99	7.93

Appendix 7.2. Continued.

			Status 1 or 2		Status 3 or 4		Public	
Common	**Scientific**	**Total Km**	**Km**	**%**	**Km**	**%**	**Km**	**%**
blackspotted topminnow	Fundulus olivaceus	25396	485.34	1.91	872.10	3.43	1357.43	5.35
redfin shiner	Lythrurus umbratilis	67230	500.40	0.74	1615.96	2.4	2116.36	3.15
black bullhead	Ameiurus melas	130252	503.64	0.39	3957.72	3.04	4461.36	3.43
orangethroat darter	Etheostoma spectabile	116690	563.48	0.48	4701.32	4.03	5264.80	4.51
banded sculpin	Cottus carolinae	21381	592.42	2.77	1382.31	6.47	1974.73	9.24
largemouth bass	Micropterus salmoides	75254	600.42	0.8	1946.17	2.59	2546.59	3.38
yellow bullhead	Ameiurus natalis	47969	625.66	1.3	1679.68	3.5	2305.34	4.81
striped shiner	Luxilus chrysocephalus	23742	637.87	2.69	1544.32	6.5	2182.19	9.19
stippled darter	Etheostoma punctulatum	49616	638.48	1.29	3203.97	6.46	3842.45	7.74
Ozark minnow	Notropis nubilus	32584	699.64	2.15	2081.56	6.39	2781.21	8.54
white sucker	Catostomus commersoni	141436	715.71	0.51	6480.74	4.58	7196.46	5.09
longear sunfish	Lepomis megalotis	53550	747.44	1.4	2734.80	5.11	3482.25	6.5
bluntnose minnow	Pimephales notatus	125488	781.27	0.62	3361.70	2.68	4142.96	3.3
creek chubsucker	Erimyzon oblongus	36602	791.91	2.16	4086.02	11.16	4877.92	13.33
southern redbelly dace	Phoxinus erythrogaster	71504	862.25	1.21	6033.68	8.44	6895.92	9.64
hornyhead chub	Nocomis biguttatus	41015	868.57	2.12	3566.66	8.7	4435.23	10.81
fantail darter	Etheostoma flabellare	87084	906.22	1.04	6472.96	7.43	7379.18	8.47
creek chub	Semotilus atromaculatus	159085	1148.72	0.72	7665.90	4.82	8814.62	5.54
central stoneroller	Campostoma anomalum	161362	1263.02	0.78	7851.13	4.87	9114.15	5.65
bluegill	Lepomis macrochirus	173682	1342.41	0.77	8033.87	4.63	9376.28	5.4
green sunfish	Lepomis cyanellus	173546	1342.41	0.77	8023.15	4.62	9365.57	5.4
	Mussel							
fat pocketbook	Potamilus capax	4	0	0	0	0	0	0
hickorynut	Obovaria olivaria	264	0	0	0	0	0	0
Higgins eye	Lampsilis higginsii	31	0	0	0	0	0	0
southern hickorynut	Obovaria jacksoniana	299	0	0	20.01	6.69	20.01	6.69
Texas lilliput	Toxolasma texasensis	725	0	0	9.00	1.24	9.00	1.24
zebra mussel*	Dreissena polymorpha	867	0	0	15.04	1.74	15.04	1.74
Neosho mucket	Lampsilis rafinesqueana	988	1.75	0.18	42.27	4.28	44.02	4.46
salamander mussel	Simpsonaias ambigua	560	2.61	0.47	30.46	5.44	33.07	5.91
bankclimber	Plectomerus dombeyanus	812	4.05	0.5	17.95	2.21	22.00	2.71
cylindrical papershell	Anodontoides ferussacianus	2908	4.91	0.17	63.21	2.17	68.13	2.34
snuffbox	Epioblasma triquetra	921	4.93	0.54	55.08	5.98	60.01	6.52

Appendix 7.2. Continued.

			Status 1 or 2		Status 3 or 4		Public	
Common	**Scientific**	**Total Km**	**Km**	**%**	**Km**	**%**	**Km**	**%**
elephantear	Elliptio crassidens	1320	7.80	0.59	38.75	2.94	46.55	3.53
scaleshell	Leptodea leptodon	1239	7.80	0.63	19.83	1.6	27.64	2.23
sheepnose	Plethobasus cyphyus	1046	7.80	0.75	27.83	2.66	35.64	3.41
spectaclecase	Cumberlandia monodonta	1348	20.30	1.51	43.84	3.25	64.13	4.76
ebonyshell	Fusconaia ebena	385	22.32	5.8	12.08	3.14	34.40	8.94
pink papershell	Potamilus ohiensis	8246	32.29	0.39	279.22	3.39	311.51	3.78
wartyback	Quadrula nodulata	4626	41.82	0.9	127.73	2.76	169.55	3.67
pink mucket	Lampsilis abrupta	1252	44.29	3.54	43.10	3.44	87.38	6.98
washboard	Megalonaias nervosa	3386	46.21	1.36	151.15	4.46	197.36	5.83
monkeyface	Quadrula metanevra	3410	50.19	1.47	168.22	4.93	218.41	6.4
rock pocketbook	Arcidens confragosus	3128	53.98	1.73	75.85	2.43	129.83	4.15
flat floater	Anodonta suborbiculata	9555	54.06	0.57	273.00	2.86	327.06	3.42
northern brokenray	Lampsilis reeveiana brittsi	9381	63.36	0.68	398.30	4.25	461.66	4.92
pink heelsplitter	Potamilus alatus	9117	68.75	0.75	330.60	3.63	399.35	4.38
ellipse	Venustaconcha ellipsiformis	14505	73.29	0.51	523.09	3.61	596.38	4.11
pondhorn	Uniomerus tetralasmus	19607	83.01	0.42	557.21	2.84	640.22	3.27
purple lilliput	Toxolasma lividus	2338	83.83	3.59	137.63	5.89	221.46	9.47
mapleleaf	Quadrula quadrula	16303	99.14	0.61	441.23	2.71	540.37	3.31
butterfly	Ellipsaria lineolata	2044	112.12	5.49	68.88	3.37	181.00	8.85
Curtis pearlymussel	Epioblasma florentina curtisii	711	118.28	16.64	25.07	3.53	143.35	20.16
yellow sandshell	Lampsilis teres	12804	121.05	0.95	417.51	3.26	538.55	4.21
purple wartyback	Cyclonaias tuberculata	2133	124.39	5.83	92.40	4.33	216.79	10.16
rabbitsfoot	Quadrula cylindrica cylindrica	816	136.64	16.75	84.38	10.34	221.03	27.09
western fanshell	Cyprogenia aberti	1376	136.64	9.93	106.70	7.75	243.35	17.68
fawnsfoot	Truncilla donaciformis	2798	163.17	5.83	174.50	6.24	337.68	12.07
threehorn wartyback	Obliquaria reflexa	9610	169.06	1.76	250.93	2.61	419.99	4.37
Arkansas brokenray	Lampsilis reeveiana reeveiana	2386	175.50	7.36	131.53	5.51	307.03	12.87
deertoe	Truncilla truncata	4911	181.54	3.7	282.17	5.75	463.71	9.44
mucket	Actinonaias ligamentina	4720	185.83	3.94	229.53	4.86	415.37	8.8
pimpleback	Quadrula pustulosa	11421	186.04	1.63	379.42	3.32	565.47	4.95
slippershell mussel	Alasmidonta viridis	10517	196.09	1.86	502.54	4.78	698.63	6.64
round pigtoe	Pleurobema sintoxia	4574	196.25	4.29	233.79	5.11	430.04	9.4
white heelsplitter	Lasmigona complanata	16763	206.10	1.23	422.57	2.52	628.67	3.75

Appendix 7.2. Continued.

			Status 1 or 2		Status 3 or 4		Public	
Common	**Scientific**	**Total Km**	**Km**	**%**	**Km**	**%**	**Km**	**%**
spike	Elliptio dilatata	6193	212.28	3.43	259.63	4.19	471.91	7.62
black sandshell	Ligumia recta	3798	217.82	5.74	204.12	5.37	421.94	11.11
pistolgrip	Tritogonia verrucosa	12168	240.81	1.98	432.88	3.56	673.69	5.54
bleufer	Potamilus purpuratus	10036	245.67	2.45	224.80	2.24	470.46	4.69
Wabash pigtoe	Fusconaia flava	13402	255.63	1.91	447.81	3.34	703.44	5.25
elktoe	Alasmidonta marginata	6265	256.76	4.1	296.80	4.74	553.56	8.84
threeridge	Amblema plicata	17584	266.23	1.51	489.29	2.78	755.52	4.3
fragile papershell	Leptodea fragilis	18622	266.30	1.43	500.49	2.69	766.79	4.12
Asian clam*	Corbicula fluminea	13902	270.75	1.95	353.56	2.54	624.31	4.49
flutedshell	Lasmigona costata	6784	272.81	4.02	352.65	5.2	625.47	9.22
Ozark pigtoe	Fusconaia ozarkensis	4027	304.79	7.57	179.60	4.46	484.39	12.03
bleedingtooth mussel	Venustaconcha pleasi	5328	322.51	6.05	345.25	6.48	667.76	12.53
Ozark brokenray	Lampsilis reeveiana brevicula	7253	331.11	4.57	457.47	6.31	788.58	10.87
plain pocketbook	Lampsilis cardium	17329	364.48	2.1	699.17	4.03	1063.65	6.14
rainbow	Villosa iris	8188	373.07	4.56	543.74	6.64	916.81	11.2
lilliput	Toxolasma parvus	41313	411.26	1	1125.69	2.72	1536.95	3.72
little spectaclecase	Villosa lienosa	30023	416.22	1.39	2715.87	9.05	3132.09	10.43
Ouachita kidneyshell	Ptychobranchus occidentalis	23745	437.89	1.84	1195.80	5.04	1633.68	6.88
paper pondshell	Utterbackia imbecillis	50934	444.36	0.87	1473.07	2.89	1917.43	3.76
creeper	Strophitus undulatus	48752	459.97	0.94	1331.04	2.73	1791.01	3.67
pondmussel	Ligumia subrostrata	160890	1027.10	0.64	7384.81	4.59	8411.91	5.23
giant floater	Pyganodon grandis	167307	1123.79	0.67	7534.17	4.5	8657.97	5.17
fatmucket	Lampsilis siliquoidea	156834	1223.72	0.78	7748.47	4.94	8972.19	5.72
Crayfish								
Cajun dwarf crayfish	Cambarellus puer	16	0	0	0	0	0	0
digger crayfish	Fallicambarus fodiens	6	0	0	0	0	0	0
Mammoth Spring crayfish	Orconectes marchandi	12	0	0	0	0	0	0
Meek's crayfish	Orconectes meeki	126	0	0	31.55	25.04	31.55	25.04
Neosho midget crayfish	Orconectes macrus	1161	0	0	14.23	1.23	14.23	1.23
shrimp crayfish	Orconectes lancifer	96	0	0	0	0	0	0
white river crayfish	Procambarus acutus	95	0	0	11.71	12.33	11.71	12.33
Williams' crayfish	Orconectes williamsi	296	0	0	37.26	12.59	37.26	12.59
vernal crayfish	Procambarus viaeviridis	5	2.22	44.34	1.87	37.38	4.09	81.72

Appendix 7.2. Continued.

			Status 1 or 2		Status 3 or 4		Public	
Common	**Scientific**	**Total Km**	**Km**	**%**	**Km**	**%**	**Km**	**%**
belted crayfish	Orconectes harrisonii	531	2.33	0.44	7.25	1.36	9.58	1.8
Big Creek crayfish	Orconectes peruncus	675	10.01	1.48	53.60	7.94	63.61	9.42
freckled crayfish	Cambarus maculatus	1591	12.47	0.78	117.23	7.37	129.70	8.15
longpincered crayfish	Orconectes longidigitus	1201	18.92	1.58	82.44	6.86	101.36	8.44
woodland crayfish	Orconectes hylas	2044	26.43	1.29	180.42	8.83	206.85	10.12
grassland crayfish	Procambarus gracilis	35544	27.50	0.08	379.26	1.07	406.76	1.14
coldwater crayfish	Orconectes eupunctus	75	34.66	46.21	3.18	4.25	37.85	50.46
saddlebacked crayfish	Orconectes medius	7977	43.49	0.55	798.08	10	841.57	10.55
shield crayfish	Faxonella clypeata	963	50.06	5.2	70.14	7.28	120.20	12.48
red swamp crayfish	Procambarus clarkii	7475	57.07	0.76	82.85	1.11	139.92	1.87
Shufeldt's dwarf crayfish	Cambarellus shufeldtii	7402	57.07	0.77	92.70	1.25	149.76	2.02
gray-speckled crayfish	Orconectes palmeri	8696	58.94	0.68	101.84	1.17	160.78	1.85
St. Francis River crayfish	Orconectes quadruncus	3225	77.79	2.41	372.17	11.54	449.96	13.95
papershell crayfish	Orconectes immunis	48971	84.46	0.17	580.95	1.19	665.41	1.36
Hubbs' crayfish	Cambarus hubbsi	1493	99.13	6.64	108.80	7.29	207.93	13.93
ringed crayfish	Orconectes neglectus	17568	281.81	1.6	1166.71	6.64	1448.52	8.25
virile crayfish	Orconectes virilis	91821	331.03	0.36	2214.91	2.41	2545.94	2.77
golden crayfish	Orconectes luteus	24562	395.70	1.61	1038.01	4.23	1433.71	5.84
devil crayfish	Cambarus diogenes	56569	444.09	0.79	4267.91	7.54	4712.00	8.33
Ozark crayfish	Orconectes ozarkae	15920	711.37	4.47	2505.06	15.74	3216.43	20.2
spothanded crayfish	Orconectes punctimanus	58414	1119.83	1.92	5931.86	10.15	7051.70	12.07

APPENDIX 7.3

Statewide management status statistics for each fish, mussel, and crayfish species in Missouri, by distinct occurrence. Table shows the total number of AESs in which each species is predicted to occur and the number and percent of total in which each species was represented in status 1 or 2 lands. Note: Asterisk denotes nonnative species

Common	Scientific	Total number of AESs species occurs in	Number of AESs in which species was represented in status 1 or 2 lands	Percent of AESs in which species was represented in status 1 or 2 lands
Fish				
alligator gar	Atractosteus spatula	17	0	0
bluntface shiner	Cyprinella camura	14	0	0
brassy minnow	Hybognathus hankinsoni	37	0	0
burbot	Lota lota	23	0	0
central mudminnow	Umbra limi	1	0	0
channel darter	Percina copelandi	12	0	0
cypress minnow	Hybognathus hayi	5	0	0
dollar sunfish	Lepomis marginatus	2	0	0
golden topminnow	Fundulus chrysotus	1	0	0
goldstripe darter	Etheostoma parvipinne	1	0	0
harlequin darter	Etheostoma histrio	4	0	0
inland silverside	Menidia beryllina	6	0	0
ironcolor shiner	Notropis chalybaeus	11	0	0
longnose darter	Percina nasuta	10	0	0
mountain madtom	Noturus eleutherus	2	0	0
Neosho madtom	Noturus placidus	1	0	0
Niangua darter	Etheostoma nianguae	16	0	0
northern pike	Esox lucius	10	0	0
plains killifish	Fundulus zebrinus	3	0	0
pumpkinseed	Lepomis gibbosus	2	0	0
redfin darter	Etheostoma whipplei	3	0	0
redspot chub	Nocomis asper	16	0	0
Sabine shiner	Notropis sabinae	2	0	0
silver lamprey	Ichthyomyzon unicuspis	11	0	0

Appendix 7.3. Continued.

Common	Scientific	Total number of AESs species occurs in	Number of AESs in which species was represented in status 1 or 2 lands	Percent of AESs in which species was represented in status 1 or 2 lands
silverjaw minnow	Notropis buccatus	36	0	0
spottail shiner	Notropis hudsonius	20	0	0
striped mullet	Mugil cephalus	15	0	0
swamp darter	Etheostoma fusiforme	1	0	0
taillight shiner	Notropis maculatus	4	0	0
threadfin shad	Dorosoma petenense	13	0	0
yellow bass	Morone mississippiensis	29	0	0
yellow perch	Perca flavescens	1	0	0
Alabama shad	Alosa alabamae	36	1	2.78
Arkansas darter	Etheostoma cragini	9	1	11.11
bighead carp*	Hypophthalmichthys nobilis	65	1	1.54
blue catfish	Ictalurus furcatus	78	1	1.28
brindled madtom	Noturus miurus	38	1	2.63
brown bullhead	Ameiurus nebulosus	6	1	16.67
cardinal shiner	Luxilus cardinalis	18	1	5.56
channel shiner	Notropis wickliffi	33	1	3.03
flathead chub	Platygobio gracilis	60	1	1.67
goldfish*	Carassius auratus	19	1	5.26
grass carp*	Ctenopharyngodon idella	57	1	1.75
lake sturgeon	Acipenser fulvescens	54	1	1.85
least darter	Etheostoma microperca	40	1	2.5
pallid sturgeon	Scaphirhynchus albus	51	1	1.96
rainbow smelt*	Osmerus mordax	44	1	2.27
shoal chub	Macrhybopsis hyostoma	99	1	1.01
sicklefin chub	Macrhybopsis meeki	50	1	2
silver carp*	Hypophthalmichthys molitrix	57	1	1.75
silverband shiner	Notropis shumardi	36	1	2.78
stargazing darter	Percina uranidea	4	1	25
starhead topminnow	Fundulus dispar	9	1	11.11
striped bass*	Morone saxatilis	18	1	5.56
sturgeon chub	Macrhybopsis gelida	47	1	2.13
Topeka shiner	Notropis topeka	66	1	1.52

Appendix 7.3. Continued.

Common	Scientific	Total number of AESs species occurs in	Number of AESs in which species was represented in status 1 or 2 lands	Percent of AESs in which species was represented in status 1 or 2 lands
bantam sunfish	Lepomis symmetricus	3	2	66.67
blue sucker	Cycleptus elongatus	93	2	2.15
bowfin	Amia calva	70	2	2.86
brown trout*	Salmo trutta	16	2	12.5
crystal darter	Crystallaria asprella	33	2	6.06
Mississippi silvery minnow	Hybognathus nuchalis	48	2	4.17
mud darter	Etheostoma asprigene	45	2	4.44
pallid shiner	Notropis amnis	48	2	4.17
river darter	Percina shumardi	52	2	3.85
saddleback darter	Percina vigil	40	2	5
scaly sand darter	Ammocrypta vivax	33	2	6.06
shovelnose sturgeon	Scaphirhynchus platorynchus	67	2	2.99
western sand darter	Ammocrypta clara	46	2	4.35
white bass	Morone chrysops	140	2	1.43
Arkansas saddled darter	Etheostoma euzonum	15	3	20
brook darter	Etheostoma burri	10	3	30
ghost shiner	Notropis buchanani	196	3	1.53
goldeye	Hiodon alosoides	140	3	2.14
lake chubsucker	Erimyzon sucetta	26	3	11.54
plains minnow	Hybognathus placitus	186	3	1.61
silver chub	Macrhybopsis storeriana	173	3	1.73
slim minnow	Pimephales tenellus	33	3	9.09
banded pygmy sunfish	Elassoma zonatum	40	4	10
blacknose shiner	Notropis heterolepis	56	4	7.14
blackside darter	Percina maculata	114	4	3.51
bluestripe darter	Percina cymatotaenia	34	4	11.76
highfin carpsucker	Carpiodes velifer	50	4	8
trout-perch	Percopsis omiscomaycus	85	4	4.71
yoke darter	Etheostoma juliae	29	4	13.79
American brook lamprey	Lampetra appendix	9	5	55.56
bluntnose darter	Etheostoma chlorosomum	87	5	5.75
common shiner	Luxilus cornutus	89	5	5.62

Appendix 7.3. Continued.

Common	Scientific	Total number of AESs species occurs in	Number of AESs in which species was represented in status 1 or 2 lands	Percent of AESs in which species was represented in status 1 or 2 lands
flier	Centrarchus macropterus	22	5	22.73
gravel chub	Erimystax x-punctatus	95	5	5.26
mimic shiner	Notropis volucellus	79	5	6.33
mooneye	Hiodon tergisus	55	5	9.09
Ozark bass	Ambloplites constellatus	41	5	12.2
river shiner	Notropis blennius	131	5	3.82
sauger	Stizostedion canadense	112	5	4.46
southern brook lamprey	Ichthyomyzon gagei	52	5	9.62
cypress darter	Etheostoma proeliare	42	6	14.29
dusky darter	Percina sciera	51	6	11.76
freckled madtom	Noturus nocturnus	77	6	7.79
northern brook lamprey	Ichthyomyzon fossor	20	6	30
pugnose minnow	Opsopoeodus emiliae	45	6	13.33
rainbow trout*	Oncorhynchus mykiss	44	6	13.64
ribbon shiner	Lythrurus fumeus	33	6	18.18
skipjack herring	Alosa chrysochloris	74	6	8.11
slough darter	Etheostoma gracile	79	6	7.59
spotted gar	Lepisosteus oculatus	65	6	9.23
steelcolor shiner	Cyprinella whipplei	76	6	7.89
weed shiner	Notropis texanus	38	6	15.79
western silvery minnow	Hybognathus argyritis	116	6	5.17
black buffalo	Ictiobus niger	147	7	4.76
blacktail shiner	Cyprinella venusta	45	7	15.56
bullhead minnow	Pimephales vigilax	135	7	5.19
checkered madtom	Noturus flavater	32	7	21.88
emerald shiner	Notropis atherinoides	261	7	2.68
slenderhead darter	Percina phoxocephala	182	7	3.85
speckled darter	Etheostoma stigmaeum	66	7	10.61
Missouri saddled darter	Etheostoma tetrazonum	84	8	9.52
paddlefish	Polyodon spathula	119	8	6.72
quillback	Carpiodes cyprinus	277	8	2.89
rock bass	Ambloplites rupestris	76	8	10.53

Appendix 7.3. Continued.

Common	Scientific	Total number of AESs species occurs in	Number of AESs in which species was represented in status 1 or 2 lands	Percent of AESs in which species was represented in status 1 or 2 lands
spotfin shiner	Cyprinella spiloptera	83	8	9.64
spotted sucker	Minytrema melanops	91	8	8.79
duskystripe shiner	Luxilus pilsbryi	33	9	27.27
mottled sculpin	Cottus bairdi	64	9	14.06
pirate perch	Aphredoderus sayanus	63	9	14.29
plains topminnow	Fundulus sciadicus	51	9	17.65
redear sunfish	Lepomis microlophus	53	9	16.98
river redhorse	Moxostoma carinatum	107	9	8.41
shortnose gar	Lepisosteus platostomus	290	9	3.1
smallmouth buffalo	Ictiobus bubalus	286	9	3.15
chestnut lamprey	Ichthyomyzon castaneus	167	10	5.99
Current darter	Etheostoma uniporum	27	10	37.04
gilt darter	Percina evides	52	10	19.23
Ozark shiner	Notropis ozarcanus	30	10	33.33
spotted bass	Micropterus punctulatus	238	10	4.2
stonecat	Noturus flavus	257	10	3.89
tadpole madtom	Noturus gyrinus	181	10	5.52
silver redhorse	Moxostoma anisurum	114	11	9.65
American eel	Anguilla rostrata	116	12	10.34
Ozark madtom	Noturus albater	42	12	28.57
river carpsucker	Carpiodes carpio	372	12	3.23
suckermouth minnow	Phenacobius mirabilis	430	12	2.79
bigmouth shiner	Notropis dorsalis	270	13	4.81
black crappie	Pomoxis nigromaculatus	169	13	7.69
blackstripe topminnow	Fundulus notatus	227	13	5.73
chain pickerel	Esox niger	34	13	38.24
flathead catfish	Pylodictis olivaris	355	13	3.66
Ozark chub	Erimystax harryi	57	13	22.81
Johnny darter	Etheostoma nigrum	334	14	4.19
walleye	Stizostedion vitreum	148	14	9.46
whitetail shiner	Cyprinella galactura	67	14	20.9
fathead minnow	Pimephales promelas	373	16	4.29

Appendix 7.3. Continued.

Common	Scientific	Total number of AESs species occurs in	Number of AESs in which species was represented in status 1 or 2 lands	Percent of AESs in which species was represented in status 1 or 2 lands
red shiner	Cyprinella lutrensis	441	16	3.63
redspotted sunfish	Lepomis miniatus	71	16	22.54
sand shiner	Notropis stramineus	429	16	3.73
bigmouth buffalo	Ictiobus cyprinellus	370	17	4.59
freshwater drum	Aplodinotus grunniens	347	17	4.9
warmouth	Chaenobryttus gulosus	191	17	8.9
banded darter	Etheostoma zonale	142	18	12.68
logperch	Percina caprodes	328	18	5.49
white crappie	Pomoxis annularis	461	19	4.12
golden redhorse	Moxostoma erythrurum	310	20	6.45
longnose gar	Lepisosteus osseus	340	20	5.88
shadow bass	Ambloplites ariommus	76	20	26.32
Ozark sculpin	Cottus hypselurus	99	21	21.21
wedgespot shiner	Notropis greenei	113	21	18.58
golden shiner	Notemigonus crysoleucas	427	22	5.15
telescope shiner	Notropis telescopus	83	22	26.51
bigeye chub	Notropis amblops	126	23	18.25
bigeye shiner	Notropis boops	181	23	12.71
least brook lamprey	Lampetra aepyptera	84	23	27.38
channel catfish	Ictalurus punctatus	505	24	4.75
stippled darter	Etheostoma punctulatum	123	24	19.51
orangespotted sunfish	Lepomis humilis	483	25	5.18
bleeding shiner	Luxilus zonatus	153	26	16.99
brook silverside	Labidesthes sicculus	330	26	7.88
grass pickerel	Esox americanus	105	26	24.76
rosyface shiner	Notropis rubellus	200	26	13
black redhorse	Moxostoma duquesnei	218	28	12.84
northern hog sucker	Hypentelium nigricans	223	28	12.56
slender madtom	Noturus exilis	280	28	10
greenside darter	Etheostoma blennioides	199	29	14.57
shorthead redhorse	Moxostoma macrolepidotum	385	29	7.53
banded sculpin	Cottus carolinae	192	30	15.62

Appendix 7.3. Continued.

Common	Scientific	Total number of AESs species occurs in	Number of AESs in which species was represented in status 1 or 2 lands	Percent of AESs in which species was represented in status 1 or 2 lands
creek chubsucker	Erimyzon oblongus	101	30	29.7
smallmouth bass	Micropterus dolomieu	268	30	11.19
rainbow darter	Etheostoma caeruleum	176	31	17.61
western mosquitofish	Gambusia affinis	387	33	8.53
largescale stoneroller	Campostoma oligolepis	208	34	16.35
northern studfish	Fundulus catenatus	216	34	15.74
gizzard shad	Dorosoma cepedianum	474	35	7.38
blackspotted topminnow	Fundulus olivaceus	236	36	15.25
common carp*	Cyprinus carpio	542	37	6.83
striped shiner	Luxilus chrysocephalus	226	37	16.37
Ozark minnow	Notropis nubilus	202	39	19.31
redfin shiner	Lythrurus umbratilis	450	40	8.89
hornyhead chub	Nocomis biguttatus	216	42	19.44
orangethroat darter	Etheostoma spectabile	355	45	12.68
black bullhead	Ameiurus melas	522	47	9
longear sunfish	Lepomis megalotis	309	47	15.21
southern redbelly dace	Phoxinus erythrogaster	208	47	22.6
yellow bullhead	Ameiurus natalis	458	49	10.7
fantail darter	Etheostoma flabellare	284	51	17.96
white sucker	Catostomus commersoni	475	51	10.74
largemouth bass	Micropterus salmoides	542	53	9.17
bluntnose minnow	Pimephales notatus	531	62	11.68
creek chub	Semotilus atromaculatus	510	62	12.16
central stoneroller	Campostoma anomalum	515	63	12.23
bluegill	Lepomis macrochirus	542	71	12.16
green sunfish	Lepomis cyanellus	542	71	12.18
Mussel				
fat pocketbook	Potamilus capax	1	0	0
hickorynut	Obovaria olivaria	6	0	0
Higgins eye	Lampsilis higginsii	2	0	0
southern hickorynut	Obovaria jacksoniana	14	0	0
Texas lilliput	Toxolasma texasensis	7	0	0

Appendix 7.3. Continued.

Common	Scientific	Total number of AESs species occurs in	Number of AESs in which species was represented in status 1 or 2 lands	Percent of AESs in which species was represented in status 1 or 2 lands
zebra mussel*	Dreissena polymorpha	27	0	0
cylindrical papershell	Anodontoides ferussacianus	65	1	1.54
Neosho mucket	Lampsilis rafinesqueana	32	1	3.12
salamander mussel	Simpsonaias ambigua	12	1	8.33
bankclimber	Plectomerus dombeyanus	22	2	9.09
elephantear	Elliptio crassidens	32	2	6.25
scaleshell	Leptodea leptodon	25	2	8
sheepnose	Plethobasus cyphyus	20	2	10
ebonyshell	Fusconaia ebena	16	3	18.75
pink mucket	Lampsilis abrupta	33	3	9.09
snuffbox	Epioblasma triquetra	23	3	13.04
spectaclecase	Cumberlandia monodonta	27	3	11.11
wartyback	Quadrula nodulata	117	4	3.42
rock pocketbook	Arcidens confragosus	53	5	9.43
butterfly	Ellipsaria lineolata	54	6	11.11
Curtis pearlymussel	Epioblasma florentina curtisii	34	6	17.65
pink papershell	Potamilus ohiensis	269	6	2.23
washboard	Megalonaias nervosa	101	6	5.94
fawnsfoot	Truncilla donaciformis	83	7	8.43
monkeyface	Quadrula metanevra	94	7	7.45
purple wartyback	Cyclonaias tuberculata	57	7	12.28
rabbitsfoot	Quadrula cylindrica cylindrica	30	7	23.33
western fanshell	Cyprogenia aberti	45	7	15.56
flat floater	Anodonta suborbiculata	294	8	2.72
pink heelsplitter	Potamilus alatus	295	9	3.05
northern brokenray	Lampsilis reeveiana brittsi	72	10	13.89
purple lilliput	Toxolasma lividus	71	10	14.08
threehorn wartyback	Obliquaria reflexa	108	10	9.26
Arkansas brokenray	Lampsilis reeveiana reeveiana	51	12	23.53
deertoe	Truncilla truncata	150	13	8.67
ellipse	Venustaconcha ellipsiformis	158	13	8.23
mapleleaf	Quadrula quadrula	355	13	3.66

Appendix 7.3. Continued.

Common	Scientific	Total number of AESs species occurs in	Number of AESs in which species was represented in status 1 or 2 lands	Percent of AESs in which species was represented in status 1 or 2 lands
mucket	Actinonaias ligamentina	164	13	7.93
bleufer	Potamilus purpuratus	102	14	13.73
black sandshell	Ligumia recta	106	15	14.15
pondhorn	Uniomerus tetralasmus	322	15	4.66
round pigtoe	Pleurobema sintoxia	151	15	9.93
yellow sandshell	Lampsilis teres	395	15	3.8
pimpleback	Quadrula pustulosa	330	16	4.85
slippershell mussel	Alasmidonta viridis	105	17	16.19
white heelsplitter	Lasmigona complanata	325	17	5.23
pistolgrip	Tritogonia verrucosa	359	18	5.01
spike	Elliptio dilatata	189	18	9.52
bleedingtooth mussel	Venustaconcha pleasi	81	19	23.46
elktoe	Alasmidonta marginata	176	19	10.8
Ozark pigtoe	Fusconaia ozarkensis	108	19	17.59
Asian clam*	Corbicula fluminea	264	21	7.95
Ozark brokenray	Lampsilis reeveiana brevicula	103	21	20.39
threeridge	Amblema plicata	359	21	5.85
flutedshell	Lasmigona costata	200	23	11.5
fragile papershell	Leptodea fragilis	415	23	5.54
Ouachita kidneyshell	Ptychobranchus occidentalis	110	23	20.91
Wabash pigtoe	Fusconaia flava	404	23	5.69
little spectaclecase	Villosa lienosa	112	25	22.32
rainbow	Villosa iris	103	27	26.21
plain pocketbook	Lampsilis cardium	430	34	7.91
paper pondshell	Utterbackia imbecillis	502	36	7.17
lilliput	Toxolasma parvus	482	37	7.68
creeper	Strophitus undulatus	499	42	8.42
pondmussel	Ligumia subrostrata	514	60	11.67
giant floater	Pyganodon grandis	542	64	11.37
fatmucket	Lampsilis siliquoidea	506	65	12.85
Crayfish				
Cajun dwarf crayfish	Cambarellus puer	3	0	0

Appendix 7.3. Continued.

Common	Scientific	Total number of AESs species occurs in	Number of AESs in which species was represented in status 1 or 2 lands	Percent of AESs in which species was represented in status 1 or 2 lands
digger crayfish	Fallicambarus fodiens	2	0	0
Mammoth Spring crayfish	Orconectes marchandi	1	0	0
Meek's crayfish	Orconectes meeki	4	0	0
Neosho midget crayfish	Orconectes macrus	16	0	0
shrimp crayfish	Orconectes lancifer	2	0	0
White River crayfish	Procambarus acutus	21	0	0
Williams' crayfish	Orconectes williamsi	14	0	0
belted crayfish	Orconectes harrisonii	7	1	14.29
shield crayfish	Faxonella clypeata	11	1	9.09
vernal crayfish	Procambarus viaeviridis	3	1	33.33
Big Creek crayfish	Orconectes peruncus	7	2	28.57
coldwater crayfish	Orconectes eupunctus	6	3	50
freckled crayfish	Cambarus maculatus	16	3	18.75
St. Francis River crayfish	Orconectes quadruncus	7	4	57.14
gray-speckled crayfish	Orconectes palmeri	35	5	14.29
longpincered crayfish	Orconectes longidigitus	31	5	16.13
red swamp crayfish	Procambarus clarkii	26	5	19.23
Shufeldt's dwarf crayfish	Cambarellus shufeldtii	26	5	19.23
saddlebacked crayfish	Orconectes medius	16	6	37.5
woodland crayfish	Orconectes hylas	17	6	35.29
Hubbs' crayfish	Cambarus hubbsi	49	10	20.41
ringed crayfish	Orconectes neglectus	49	10	20.41
grassland crayfish	Procambarus gracilis	324	11	3.4
papershell crayfish	Orconectes immunis	313	14	4.47
Ozark crayfish	Orconectes ozarkae	59	20	33.9
golden crayfish	Orconectes luteus	262	31	11.83
devil crayfish	Cambarus diogenes	456	39	8.55
virile crayfish	Orconectes virilis	483	40	8.28
spothanded crayfish	Orconectes punctimanus	143	45	31.47

APPENDIX 8.1

Target species list for the Ozark/Meramec EDU showing global and state conservation ranks (from Missouri Natural Heritage Program), endemism level (corresponds to the MoRAP classification hierarchy), and the number of conservation opportunity areas (COA) in which each species occurs.

Common	Scientific	Grank	Srank	Endemism	COA Count
Fish					
Alabama shad	Alosa alabamae	G3	S2	Region	3
banded darter	Etheostoma zonale	G5	S?	Region	8
banded sculpin	Cottus carolinae	G5	S?	Region	9
bigeye chub	Notropis amblops	G5	S?	Region	11
bigeye shiner	Notropis boops	G5	S?	Region	11
bigmouth shiner	Notropis dorsalis	G5	S?	Region	3
black redhorse	Moxostoma duquesnei	G5	S?	Region	11
blacknose shiner	Notropis heterolepis	G4	S2	Subzone	1
blackspotted topminnow	Fundulus olivaceus	G5	S?	Region	11
blackstripe topminnow	Fundulus notatus	G5	S?	Region	8
bleeding shiner	Luxilus zonatus	G5	S?	Subregion	11
blue sucker	Cycleptus elongatus	G3G4	S3	Region	1
bluegill	Lepomis macrochirus	G5	S?	Subzone	11
bluntnose minnow	Pimephales notatus	G5	S?	Subzone	11
brook silverside	Labidesthes sicculus	G5	S?	Subzone	10
chestnut lamprey	Ichthyomyzon castaneus	G4	S?	Region	8
creek chubsucker	Erimyzon oblongus	G5	S?	Subzone	5
crystal darter	Crystallaria asprella	G3	S1	Region	4
fantail darter	Etheostoma flabellare	G5	S?	Subzone	11
flathead chub	Platygobio gracilis	G5	S1	Subzone	1
flier	Centrarchus macropterus	G5	S3	Subzone	3
ghost shiner	Notropis buchanani	G5	S2	Region	1
gilt darter	Percina evides	G4	S?	Region	7
golden redhorse	Moxostoma erythrurum	G5	S?	Subzone	10
grass pickerel	Esox americanus	G5	S?	Subzone	10
gravel chub	Erimystax x-punctatus	G4	S?	Region	8
green sunfish	Lepomis cyanellus	G5	S?	Region	11
greenside darter	Etheostoma blennioides	G5	S?	Region	11
highfin carpsucker	Carpiodes velifer	G4G5	S2	Region	4
hornyhead chub	Nocomis biguttatus	G5	S?	Region	11
lake chubsucker	Erimyzon sucetta	G5	S2	Subzone	1
largemouth bass	Micropterus salmoides	G5	S?	Subzone	11
largescale stoneroller	Campostoma oligolepis	G5	S?	Region	11
least brook lamprey	Lampetra aepyptera	G5	S4	Region	6
logperch	Percina caprodes	G5	S?	Subzone	10

Appendix 8.1. Continued.

Common	Scientific	Grank	Srank	Endemism	COA Count
longear sunfish	Lepomis megalotis	G5	S?	Subzone	11
Mississippi silvery minnow	Hybognathus nuchalis	G5	S3S4	Region	3
Missouri saddled darter	Etheostoma tetrazonum	G5	S?	Subregion	11
mooneye	Hiodon tergisus	G5	S3	Subzone	5
mottled sculpin	Cottus bairdi	G5	S4	Subzone	11
northern brook lamprey	Ichthyomyzon fossor	G4	S4	Subzone	2
northern hog sucker	Hypentelium nigricans	G5	S?	Subzone	11
northern studfish	Fundulus catenatus	G5	S?	Region	11
orangespotted sunfish	Lepomis humilis	G5	S?	Region	9
orangethroat darter	Etheostoma spectabile	G5	S?	Region	11
Ozark minnow	Notropis nubilus	G5	S?	Subregion	10
paddlefish	Polyodon spathula	G4	S3	Region	4
plains minnow	Hybognathus placitus	G4	S2	Region	1
plains topminnow	Fundulus sciadicus	G4	S3	Region	1
rainbow darter	Etheostoma caeruleum	G5	S?	Subzone	11
redear sunfish	Lepomis microlophus	G5	S?	Subzone	6
river darter	Percina shumardi	G5	S3	Region	1
river redhorse	Moxostoma carinatum	G4	S?	Region	8
rock bass	Ambloplites rupestris	G5	S?	Subzone	11
rosyface shiner	Notropis rubellus	G5	S?	Subzone	11
sand shiner	Notropis stramineus	G5	S?	Subzone	9
silver chub	Macrhybopsis storeriana	G5	S3	Region	1
silver redhorse	Moxostoma anisurum	G5	S?	Subzone	9
silverjaw minnow	Notropis buccatus	G5	S4	Region	6
slender madtom	Noturus exilis	G5	S?	Region	10
smallmouth bass	Micropterus dolomieu	G5	S?	Subzone	11
southern cavefish	Typhlichthys subterraneus	G4	S2S3	Subzone	1
southern redbelly dace	Phoxinus erythrogaster	G5	S?	Region	11
spotfin shiner	Cyprinella spiloptera	G5	S?	Subzone	11
spotted gar	Lepisosteus oculatus	G5	S5	Region	1
steelcolor shiner	Cyprinella whipplei	G5	S?	Region	11
stippled darter	Etheostoma punctulatum	G4	S?	Subregion	1
stonecat	Noturus flavus	G5	S?	Subzone	7
striped shiner	Luxilus chrysocephalus	G5	S?	Region	11
suckermouth minnow	Phenacobius mirabilis	G5	S?	Region	7
wedgespot shiner	Notropis greenei	G5	S?	Subregion	11
western sand darter	Ammocrypta clara	G3	S2S3	Region	3
western silvery minnow	Hybognathus argyritis	G4	S2	Region	1
yellow bullhead	Ameiurus natalis	G5	S?	Subzone	11
Mussel					
black sandshell	Ligumia recta	G5	S1S2	Subzone	7
butterfly	Ellipsaria lineolata	G4	S?	Region	4
creeper	Strophitus undulatus	G5	S?	Subzone	11
cylindrical papershell	Anodontoides ferussacianus	G5	S1?	Subzone	1
ebonyshell	Fusconaia ebena	G4G5	S1?	Region	2
elephantear	Elliptio crassidens	G5	S1	Region	4
elktoe	Alasmidonta marginata	G4	S2?	Subzone	11

Appendix 8.1. Continued.

Common	Scientific	Grank	Srank	Endemism	COA Count
ellipse	Venustaconcha ellipsiformis	G3G4	S?	Subzone	11
fawnsfoot	Truncilla donaciformis	G5	S?	Region	7
flutedshell	Lasmigona costata	G5	S?	Subzone	11
monkeyface	Quadrula metanevra	G4	S?	Region	7
northern brokenray	Lampsilis reeveiana brittsi	G3T2	S?	Subregion	11
Ouachita kidneyshell	Ptychobranchus occidentalis	G3G4	S2S3	Subregion	5
pink mucket	Lampsilis abrupta	G2	S2	Region	3
purple wartyback	Cyclonaias tuberculata	G5	S?	Region	5
rock pocketbook	Arcidens confragosus	G4	S3	Region	3
round pigtoe	Pleurobema sintoxia	G4	S?	Region	8
salamander mussel	Simpsonaias ambigua	G3	S1?	Region	5
scaleshell	Leptodea leptodon	G1	S1S2	Region	4
sheepnose	Plethobasus cyphyus	G3	S1	Region	7
slippershell mussel	Alasmidonta viridis	G4G5	S?	Subzone	11
snuffbox	Epioblasma triquetra	G3	S1	Region	7
spectaclecase	Cumberlandia monodonta	G2G3	S3	Region	4
threehorn wartyback	Obliquaria reflexa	G5	S?	Region	4
Crayfish					
belted crayfish	Orconectes harrisonii	G3	S3	EDU	6
freckled crayfish	Cambarus maculatus	G4	S3	EDU	10
golden crayfish	Orconectes luteus	G5	S?	Subregion	11
saddlebacked crayfish	Orconectes medius	G4	S3?	EDU	10
Salem cave crayfish	Cambarus hubrichti	G2	S3	Subregion	1
spothanded crayfish	Orconectes punctimanus	G4G5	S?	Subregion	11
woodland crayfish	Orconectes hylas	G4	S3?	EDU	4